

1001 QUESTIONS
ANSWERED
ABOUT YOUR AQUARIUM



FIGHTING FISHES

Fighting Fishes (*Betta splendens*), blue and red adults, also the Cambodia *Betta splendens* and five young Cambodia three months old.

Strikingly colored Fighting Fishes have been produced by crossing the blue *B. splendens* and the Cambodia. There is no end to the color variations that may be produced by selective breeding.

1001 QUESTIONS ANSWERED ABOUT YOUR AQUARIUM

TOY FISHES - FRESH BRACKISH AND SALT WATER

Also your Garden Pool and Terrarium

By

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SAN FRANCISCO, CALIFORNIA

WITH AN INTRODUCTION

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INTRODUCTION

The charm of a public aquarium is apparent to all who visit such an institution, but to its owner, still more fascinating is the "home aquarium." Not only does a well kept aquarium provide a constant delight to the eye, but it gives its possessor the opportunity of studying the habits of the inhabitants of the under-water world, for even the small aquarium can hold up the mirror to Nature in a manner impossible with any other form of zoological collection. In the early days of aquarium keeping, the aquarist's choice of fish was limited almost exclusively to those inhabiting our own fresh waters. Whilst many of these are quite hardy, the majority are so used to spacious surroundings that the ordinary aquarium offers but little scope for increase of size and far less for breeding. But the enormous strides made in transport and mechanical devices such as electric heaters and aerating appliances have now placed within everybody's reach a host of tropical fishes whose small size and simple requirements commend them to aquarists with limited space at their disposal. The number of different kinds of "Tropicals" and "Sub-tropicals" now upon the market number hundreds. Most of these are of small size and are either of bizarre form or gorgeous colouring, rivalling the birds and butterflies of their native lands. Many of these, which as mere ornaments are sufficiently satisfying, undergo life cycles full of spectacle and adventure—aquatic dramas that can be staged within a few gallons of water kept in an ordinary living room. Some, like the Chinese Paradise Fish and Siamese Fighting Fish, build fairylike nests of bubbles on the surface of the water, whilst others, such as the Cichlids, fashion cradles in the floor of their tank for the reception of their eggs and young. One common tropical aquarium fish even keeps its progeny safely housed within its bulging cheeks. Such are a few of the wonders—at one time only known to a few specialists—which modern progress has brought within the ken of amateur aquarists.

It would not be an exaggeration to say that in Europe and America today over a million householders are either aquarists or pond keepers and this hobby has not only created an enormous business in the supply of aquaria fishes and aquatic plants, but has given rise to a mass of literature. Much of this literature, although in some

cases admirable, is often either too limited in its scope, or too discursive. Miss Ida M. Mellen and Mr Robert J. Lanier have produced a book which, whilst concise, is encyclopedic and one that can be cordially recommended to all—tyros and experienced aquarists alike. The authors are complete masters of their subject and have long been recognised as such upon the other side of the Atlantic.

This lavishly illustrated volume, originally produced in America, will be welcomed in any country in which fish ponds or aquaria are kept. The book deals with hardy, temperate and tropical fish and plants, both fresh-water and marine. The feeding of aquarium fish, their breeding habits, growth, diseases, and enemies all come within its scope. Every conceivable phase of the subject is included and its utility to the aquarist can hardly be over-rated. As Director of the Zoological Society's Aquarium, I do not hesitate, from an entirely selfish point of view, to confess an urgent hope that this book may have a very wide vogue in this country, since its popularity would no doubt not only reduce the number of odoriferous bodies which at present I receive daily for identification and post mortem examination, but would also save me from a mass of correspondence and being called to the telephone a dozen times or more in a day to answer a multitude of questions which "1001 Questions Answered about Your Aquarium," sets for ever at rest.

E. G. BOULENGER.

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ABOUT AQUARIUM FISHES IN GENERAL

1. How many known species of fishes are there?

There are some 30,000 known species. New species are being recorded almost every week.

2. How many species of fishes are suitable for the home aquarium?

Nearly all small fishes and the young of many large fishes (other than Pikes, Gars, and similar voracious kinds) are suitable. It would be impossible to state their number.

Of toy tropicals about 80 species commonly are available in the pet shops of many large cities of the United States and exhibitions of aquarium societies have displayed 160 or more. It is estimated that throughout the world about 600 species of pigmy fishes exist which are suitable for the home aquarium, and that 300 of these have at some time reached the United States.

3. How many aquarium societies are there in the United States?

Lists were published in *Aquarium News* for October and November 1934, and adding to these the societies which have come into existence since, we appear to have 64 aquarium societies, in the following states:

California	5	Minnesota	1
Connecticut	2	New Jersey	6
District of Columbia	1	New York	16
Florida	1	Ohio	4
Illinois	2	Oregon	2
Indiana	1	Pennsylvania	10
Maryland	1	South Carolina	2
Massachusetts	3	Washington	3
Michigan	3	Wisconsin	

Besides these there are 9 in Canada, making 73 in North America.

4. Which is the oldest aquarium society in the United States?

The Aquarium Society of New York, organized in 1892.

1001 QUESTIONS ANSWERED

5. What is the difference between a fish that is compressed and one that is depressed?

Compressed means flattened laterally (from side to side) as are the Harrier Fishes, *scalars*, and others. Depressed means a dorso-ventral flattening as in the Sea Angler or Goosefish, Skates, Sea Bats, Rays and other ocean fishes.

6. Do fishes have organs like higher animals?

Fishes have digestive, reproductive and circulatory organs, including a simple heart.

7. Have fishes nerves?

They have nerves like other animals.

8. Could a fish swim and balance itself without a swim bladder?

Few fishes lack a swim bladder, but those that have none swim and balance themselves almost as well.

9. Do fishes sleep?

It is sometimes said of a fish that it was "caught napping," by which it is meant that it was asleep.

Fishes rest and appear to sleep, though their eyes remain open, the vast majority having no eyelids. If a light is turned on in a room in which Goldfishes have been kept in the dark for a time, they may be seen rousing themselves like animals that have been asleep.

10. Has a fish any means of defense?

The majority of fishes are without defensive organs, but some have knifelike spines for inflicting wounds and connected with these others have poison glands. Some can give an electric shock, others have sharp teeth and use them effectively. Some enjoy protective coloration, and a few species can puff themselves into a ball not easily swallowed by their natural enemies. A limited number in both fresh and salt water can escape from their pursuers by "flight," their long, winglike pectorals enabling them to leave the water and skip for considerable distances above the surface.

11. Are any small aquarium fishes dangerous to handle?

Not any, unless it be some species of Catfishes, the Turkey Fish and others with sharp dorsal spines connected with poison glands. In the Surgeonfishes, a sharp spine at the base of the caudal fin can be opened like a jack-knife.

ABOUT YOUR AQUARIUM

12. What is the smallest known fish?

The smallest known fish, which is likewise the smallest known vertebrate, is *Pandaka pygmaea* of the Philippine Islands, with a maximum length of one-quarter inch in the male, seven-sixteenths of an inch in the female.

Among North American native fishes of minute size is the smallest of live-bearers, the American Top Minnow (*Heterandria formosa*) of southern fresh waters, full grown males of which measure three-quarters of an inch and the female only slightly more. There are also the American Darters, among which is the Least Darter (*Micropogonias punctulata*), slightly over one inch in length. The male of the Everglades Pigmy Sunfish seldom exceeds one inch.

of the Characins are exceedingly small, several of the Tetras averaging only one and one-quarter inches. The Spotted *Lasbora*, also *Nannostomus marginatus*, seldom exceed one inch and some of the Barbs, as *Barbus gelius*, are only slightly longer.

But the smallest of all known fishes are four Philippine Gobies: the oft referred to Sinarapan, *Mistichthys luzonensis*, of Lake Bui, seven-sixteenths of an inch in length, maximum, and three others not so well known in the United States, *Pandaka pusilla*, found in Sitankai in the Sulu Province, one-half inch long, *Microgobius lacustris* of Laguna de Bay, the same length, and *Pandaka pygmaea*, of Sitankai, described above. Despite their minute size, these little fishes form an important food in the Philippines, many thousands being cooked together with peppers and other spices or mixed with butter and baked into small cakes. These little Gobies are egg layers.

13. Do all fishes have teeth in their jaws?

No, in some fishes (as in Goldfishes) the teeth are in the throat; in others on the tongue, and some have no teeth. Fishes' teeth are of several kinds, blunt, sharp, mosaic, et cetera.

In many fishes, the old teeth, when worn down or broken, are replaced by new ones from an inner row, which move forward to fill the gaps.

14. How do fishes breathe (or respire)?

The majority extract oxygen from the water and breathe (or respire) through their gills. Lungfishes, the Bowfin, Labyrinth fishes and others are equipped for utilizing air. In some, such as Asiatic Walking Gobies, which remain out of water a long time excepting for the tail, respiration apparently takes place through the tail as well as through the gills.

1001 QUESTIONS ANSWERED

15. What is a Walking Fish?

"Walking Fish" is a rather loose term, but the generally accepted meaning seems to be, a fish that can balance itself on its pectoral fins and make progress on land. This limits the number of Walking Fishes to such species as the Climbing Perch, Channa and Walking Goby.

Sea Robins walk on the bottom of the sea on the long, fingerlike ends of their pectoral fins.

Some fishes can maintain an upright position on land and hitch themselves through wet grass, as some of the Molly Millers, the Mud Minnows, certain Catfishes which are said to leave the water by night to forage on land, the Leaping Fish, Eel and others.

16. Do fishes have a backbone like ourselves?

Yes, they are the lowest of the animals with a backbone or vertebral column.

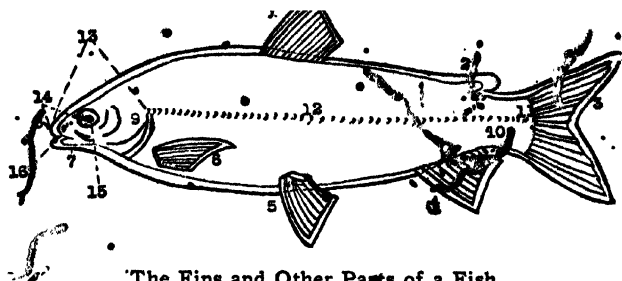
The number of their vertebræ differs greatly, some having no more than 16, others having more than 150. This was thought to depend somewhat on whether they live in cold or warm waters, some Flounders of the Arctic having 60 vertebræ while those of the tropics may have but 30; but some of the Flying Fishes of the Gulf Stream have 50 vertebræ while others of colder waters have but 25. The real reason for the variation is obscure, particularly as it is not only specific but individual. Kyle thinks it is due to "the balance of the fish, head with body."

By the "lowest" of animals is meant the lowest in the evolutionary scale, fishes being the first animals that developed a backbone and kept it through life. Intermediate forms between fishes and invertebrates (animals without a backbone) develop a backbone and later lose it. Among these is the Sea Squirt, No. 870.

17. What names are given the various fins of a fish?

The tail fin is called the caudal. Generally this fin is single, but in some, as in certain fancy Goldfishes, it is double. The fins on the sides behind the gills are called pectorals and always are single. The fins on the back are the dorsals and are also single but some fishes such as Darters and Sleepers have two dorsals, and some have three, as the Cod and Haddock. Others, such as Catfishes, the Salmon family and many Characins have one strong fin and one weak little fin on the back, the strong fin being the dorsal and the weak, fleshy one behind it an adipose fin. The dorsal fin may be spinous as in the Sunfishes and some of the Cichlids. The paired fins under-

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The Fins and Other Parts of a Fish

- | | |
|---------------------------|-------------------------|
| 1. Dorsal fin | 9. Opercle or operculum |
| 2. Adipose fin | 10. Caudal peduncle |
| 3. Caudal fin | 11. Base of caudal |
| 4. Anal fin | 12. Lateral line |
| 5. Ventral fin | 13. Head |
| 6. Pectoral fin | 14. Snout |
| 7. Lower jaw or mandible | 15. Eye |
| 8. Upper jaw or maxillary | 16. Nostrils |

neath are called ventral fins. The fin behind them, which is generally single, is the anal. In some fishes, such as the Cod, there are two anals.

18. What are fins used for?

Fishes with strong fins, especially strong tail fins, are powerful swimmers. Those with weak fins are feeble swimmers (Sea Horses, for example). The fins serve not only as swimming organs but help to steer the fish. The pectoral fins assist in maintaining equilibrium. There are many kinds of fins, round, curved, notched, single, double, fringed, et cetera. When happy and well, the fish usually keeps the dorsal fin raised; when sick or disappointed, this fin is lowered.

19. What is the opercle or operculum of a fish?

Its gill cover.

20. What is the caudal peduncle of a fish?

That part which is posterior to the anal fin, actually the support for the tail, directly in front of the base of the caudal fin.

21. Which are the most beautiful pigmy fresh-water fishes?

The Sunfishes, Dace, Minnows and Darters of the northern United States. No tropical fish is more beautiful than a Blackfin Minnow,

None excels in beauty the Darters of the middle west, which are called "the humming birds of fresh waters" by reason of their small size and rich coloration. The Green-sided Darter, a three-inch species with a curiously froglike profile, has been called "the most simply beautiful of all fresh-water fishes," but another vies with it, for the Blue-breasted Darter is regarded by some ichthyologists as the most brilliantly colored fresh-water fish in the world.

Every one who has seen our native Sunfishes knows how their bodies glitter as though set with gems, and many amateur aquarists are familiar with the Red-bellied Dace, the Rosy Dace, the Redfin Minnow and other native beauties.

22. Which are the most beautiful pigmy salt-water fishes?

Those found in tropical seas commonly are more richly colored, but occasional temperate zone species become beautiful in the courting season, and some of the tide-pool species of our Pacific are handsome.

23. Can fishes distinguish colors?

According to the experiments of Gertrude White Hiline, the Mud Minnows can distinguish groups of colors at one end of the spectrum from groups of colors at the other end, as red, orange and yellow from green, blue and violet. If food stained red, orange, or yellow proves good to eat they learn to distinguish it from food stained green, blue or violet, if this is not good to eat. Probably the same limited power of discerning colors exists in other fishes. Some ocean species learn the dangers of a white net and fishermen have found it expedient to dye their nets brown or green. (See No. 469.)

24. Can a fish change its color, and how?

Males in courting time are noted for their change of color, some assuming brilliant hues. Emotional disturbances cause a temporary change of color, as fright, hunger, anger, curiosity; or a fish may change color permanently. (See No. 657, Goldfishes.)

Change of color is effected by contracting the color cells, called chromatophores, thus moving the pigment granules within the cells. Fishes can become darker or lighter to match their surroundings. Yellow chromatophores when contracted become orange, and orange, or red appear brown or black. Blind and sick fishes do not change color.

25. Do fishes show their colors best in a new tank or an old established tank?

In an old established tank. The colors of most fishes show best when natural surroundings are provided: clear water, a well-planted tank and dusky bottom.

26. Do fishes' colors fade in captivity?

They do. The colors fade more quickly in light surroundings, as in a tank with a white tile or white sand bottom, than in darker surroundings, and this is irrespective of whether or not there are plants in the tank. Salt-water fishes do not lose color as rapidly as fresh-water kinds.

27. Do fishes see far enough to distinguish people?

They are not far-sighted. Some can see farther under water than others. They can see people through the glass of the aquarium. It has been observed that fishes long kept in home aquariums swim away when strangers approach, but swim forward when those who care for them walk near the aquarium.

The late Mr. E. K. Bruce of the Bruce Goldfish Fisheries, Iowa, wagered \$50 that his fishes knew him, the decision being based on whether they came to him and not to the stranger. He always won the bet, for invariably the fishes came to him but swam away from the stranger. These fishes had been in his possession for many years. Doubtless they learn the gestures peculiar to individuals. It is not to be supposed that they recognize the features of a person's face or shape of his hands. Sanford says they "learn with great promptness to avoid persons that have abused them," his reference being to a Trout which avoided a person who had lifted it out of the water by the tail (Bibliography No. 174.)

28. Can a fish hear?

Fishes have internal ears, apparently for help in balancing and in sensing vibrations. Hands clapped out of the water are not heard by them, but if the aquarium is jarred when the hands are clapped, they appear to recognize the "sound" though only feeling the vibration. If hands are clapped in the water, they feel the vibration keenly. Statements that fishes learn to know the ringing of a bell outside the water and come to dinner, have been found erroneous when the bell was rung by a person out of sight. It has not been proved that they distinguish the pitch or tone of sounds they recognize.

29. What senses have fishes?

Their senses of touch, smell and taste are developed in various degrees in different species. The nostrils of fishes are for smelling but not for breathing. Some have a keener sense of smell than others. The sense of touch resides principally in the skin and lips. Fishes, as a rule, do not stop to taste their food, Goldfishes being noticeable exceptions. For sense of sight and hearing, see two preceding questions.

30. What is the lateral line of a fish for?

The lateral line is believed to be a sense organ though its exact function is not understood. It distributes oil over the body and may help the fish detect vibrations and the approach of other animals. Some fishes have no lateral line, some have two or three lateral li

31. How can a fish make a noise?

Many fishes are dumb, others make considerable noise. The "clucking" of the Goldfish (more properly gasping) is produced by the lips sucking in air at the surface of the water when the fish is suffering from lack of sufficient oxygen. Puffers, while inflating, make clicking sounds with the air valve in the throat. Sea Horses make a clicking noise in eating, by snapping their bony little jaws. Some fishes make noises with the spines in their fins, some, it is said, by grating together certain sections of the backbone, and some can make noises by grinding their teeth. The air bladder has been called an "elastic spring type of vocal organ" because noises are produced by expelling gas from it. Fishes that have a valve in the throat make noises by opening it and releasing air which has been swallowed. Some fishes, such as the Red-mouthed Grunt, make a grunting sound when captured. Some ocean fishes make noise enough to keep a light sleeper awake, but one need have no fear of little aquarium fishes disturbing one's repose.

32. Do fishes show signs of old age?

It is said they show no internal signs of old age, but an experienced aquarist often can distinguish a very old fish by its outward appearance.

No observations have been recorded concerning the fishes reputed to have lived a century or longer (No. 75), but some fishes which have passed their twentieth year in captivity show no signs of senile decay. Their colors are bright and they remain active.

Some toy tropicals whose life span does not exceed three years,

ABOUT YOUR AQUARIUM

develop spinal curvature, but though this becomes more pronounced with age, Mr. Lanier believes the condition due to improper food and unnatural conditions in the aquarium, rather than to old age.

On the other hand, the difference in color and form between young and adult fishes is so great in some instances that they have been named as separate species. The Eel is an example of this, for, hatched in very saline, very deep water (300 fathoms down), it exhibits the long teeth and compressed body characteristic of some deep-sea fishes, but during metamorphosis it becomes rounded, loses the large teeth and presents an entirely altered appearance. These are not signs of old age, however.

In a state of nature, old fishes are so large that some observers have firmly believed they never stop growing. And so also in captivity, when they have sufficient swimming space they may reach a large size, besides which very old specimens sometimes exhibit enlarged fins, raised foreheads, and other external indications of age.

33. Can a fish's age be told?

In cold water fishes the age can be told by the concentric rings on the scales, also by rings on the ear stones. It is not necessary to kill the fish if the age is read from a scale. This must be carefully removed with a small forceps and the spot sterilized. Each year of life is recorded in a double group of rings on the scales. The fish grows more rapidly in summer, therefore a large area of light rings represents summer growth and a smaller, darker area, winter growth, the two together constituting one year. Except in old fishes, the age may be read by the ear stones, on which each ring represents a year.

34. Do all fishes have scales?

No, some are naturally scaleless. Fishes have several kinds of scales, spiny, enameled, rounded, rough, rhomboid, and so on.

35. How fast does a fish grow?

At very different rates, depending on food, swimming space, water content, adult proportions, season when hatched, et cetera. No rule of growth can be applied to all fishes. Captivity tends to stunt the growth of aquatic animals, and small fishes in the aquarium grow faster when they have ample swimming space and proper food. Fishes that are destined to remain small grow faster than those which will attain large proportions. They resemble other animals in this respect. (See No. 660, Goldfishes.)

36. Are male and female fishes the same size?

No, the male generally is the smaller of the two.

37. Is there any relation between the size of the egg and the size of the fish?

None. Large fishes sometimes lay much smaller eggs than do little fishes. The eggs of the Cod, for example, are much smaller than those of the Goldfish.

The number of eggs bears some relation to the number of enemies the species has. A few large eggs are laid when most will have a chance to prosper, and thousands of small eggs indicate that only a few pairs of fry will be likely to reach maturity.

38. How do fishes reproduce their kind?

In oviparous species (those which lay eggs) the female deposits her eggs and the male fertilizes them by casting his milt over them. In viviparous species (those which bring forth their young alive) the male is provided with an intromittent organ and internal fertilization takes place. The intromittent organ (called by Essenberg a gonopod and by others a gonopodium) serves to direct the milt to the puberty spot of the female.

39. Do fishes eat their own eggs or only the eggs of other fishes?

Most fishes are very fond of spawn and will eat their own eggs as well as those of other fishes.

40. If fishes bring forth their young alive, why do we not call them mammals?

Fishes are not mammals because they are not warm-blooded and do not nurture their young with milk, two outstanding characteristics of the mammal.

41. Do many fishes care for their young?

The majority of fishes drop their eggs and leave them to their fate. Some lay them in depressions cleared with the fins in mud or gravel, some build nests of bits of leaves or of carefully selected pebbles, others carry their eggs in their mouths, and after becoming free swimming the young swim back into the mouths for protection; and a few lay their eggs in empty shells or on plants or stones and care for the fry for a limited time.

As a rule it is the father who assumes the parental responsi-

bility when any exists, although in some Mouthbreeders the female carries the eggs. Some of the Catfishes, also the Pirate Perch, share parental duties, and this is a notable trait also among Cichlids, both sexes guarding eggs and fry.

Among species in which the male cares for the eggs may be mentioned the Bowfin, Toadfish, Sticklebacks, Paradise Fishes, Gouramis, Fighting Fishes, Miller's Thumbs, *Badis badis* and *Polycætrus schomburgki*.

42. Do fry hatched from eggs differ from fry born alive?

The fry of fishes hatched from eggs commonly are provided with a yolk sac (which furnishes nourishment for the young during the first few days of comparative helplessness). The new-born young of viviparous fishes are active almost immediately, and able to fend for themselves.

43. Why do some fishes remain with their eggs and fry?

The only theory advanced is that the male fish recognizes the odor of the eggs as of his own species and fertilizes them, and that "the attraction sometimes is strong enough to keep him with them until they hatch." This does not explain why some males protect the fry for a given period and then eat them. If the odor theory is correct, then the fry may retain the odor of the eggs for a time. We have no exact information on this point, nor do we know how fishes, in mating and schooling, recognize those of their own species. Guppies will school the day they are born. If it is a characteristic species odor which draws them together, this odor does not prevent the parents from eating their own young.

44. Do salt-water fishes spawn in fresh water?

Some salt-water fishes spawn in fresh water, notably the Shad and the Salmon; and a few fresh-water fishes spawn in the sea. The Eel is one of these. (See the Eel, No. 710.)

Those which leave the sea to breed in fresh water are called anadromous fishes, and those which leave fresh water to breed in the sea are called catadromous fishes.

45. Which aquarium fishes become egg-bound?

The Goldfish, also Rosy Barb, Red Tetra from Rio, Zebra Fish, Spotted Danio and other toy tropicals, especially when the females are kept by themselves.

46. Do the young of most fishes resemble their parents?

In many fishes the fry differ from the adults in a greater or less degree. Infant Eels bear no resemblance to their parents, but a baby Sea Horse can be identified immediately. Flounders pass through a profound metamorphosis and many other fishes undergo changes of form and food and habitat before reaching sexual maturity.

47. Are all fishes carnivals?

Most fishes prefer a fish diet, but some would rather feast upon crustaceans, insects, beetles, worms, mollusks and vegetation. Among the latter are Goldfishes, Darters, Wrasse fishes, Menhaden, Tangs, Parrotfishes, Tench, Roach, Rudd, Suckers, Brook Sticklebacks, *Mollienisia* and Red-bellied Dace.

48. Which fishes are adapted to breathing air?

The Labyrinth fishes are prominent among those known in American home aquaria as air-breathers. See also respiration in fishes, No. 14.

49. Which fishes can live longest out of water?

The Climbing Perch leaves the water voluntarily and can live for six days out of water. Walking Gobies can live for a number of hours on land. Other fishes which resist drying up are Goldfishes, the Bowfin, Tench, Mud Minnows, Eels, Catfishes, Puffers, Sturgeons and Toadfishes, all of which have survived for some hours out of their element. (See also No. 15.)

50. What is the largest number of eggs produced by a fish?

Among toy tropicals, *Copeina guttata* appears to head the list with a laying capacity of from 500 to 1,000 eggs, and in an occasional instance the Fighting Fishes have approximated this, as in a case reported by Mr. Henry Kissel, of 974 young raised from a single spawning.

The Goldfish ranks high in this respect, Dr. Hugh M. Smith having estimated that a Goldfish four or five years old will lay 70,000 eggs.

Some of the small European fishes used in American home aquariums and garden pools have a large egg laying capacity. The European Rudd, now generally distributed throughout the United States, lays 100,000 eggs. The Loaches are notoriously prolific and though so small a fish, the Weatherfish lays 140,000 eggs. A large Tench will lay 300,000. (Bibliography No. 16.)

Fresh-water fishes do not reach the high point of fecundity common in salt-water kinds, as: the Winter Flounder, 1,000,000; common American Eel, 5,000,000 to 10,000,000; Ling, 14,000,000 to 160,000,000; Ocean Sunfish, 300,000,000. (Bibliography No. 57.)

51. What is the largest number of young produced by a live-bearer?

In fishes of small aquarium size we have several remarkable records as, a Guppy which produced 109 young at a birth (reported by Mr. Henry P. Bruns); a *Mollienisia* which died before giving birth to well-developed young, these numbering 128 (counted by Mr. Louis L. Mowbray); the Brackish Water Millions (*Poecilia vivipara*) producing 140 in one batch (reported by Mr. P. Lechmere Guppy), and a Swordtail and Red *helleri*, each of which dropped 200 fry at one birth (reported by Mr. Henry Kissel). *Limia vittata* may produce as many as 300 fry in one batch.

Here, as in the case of oviparous fishes, we must look to the sea for high records. Norway Haddocks (*Sebastes marinus* and *S. viviparus*), marine live-bearers, produce 1,000 living young at one birth, as estimated by Ryder (Bibliography No. 220). When born, the fry of the former are six mm. long and those of *S. viviparus*, a smaller species, measure from three to five mm. in length. (However, very large marine live-bearers, as certain Sharks, produce only a small number of young, those counted thus far not exceeding 15.)

52. Will inbreeding among fishes weaken the strain?

No. Always select those that show stamina, vigor and the characteristics you wish to produce.

53. How can one raise fishes of superior size and quality?

Each species should be of known pedigree. Select the best and eliminate all poor specimens. An even temperature is necessary. Allow plenty of room, using not over one pair to each gallon of water. Prepared foods should be supplemented with numerous feedings of live food such as rotifers, white worms, *Daphnia*, mosquito larvae, brine shrimps and earthworms; also green food, especially for herbivorous fishes.

54. What kinds of eggs do fishes lay?

Five kinds: buoyant (floating on the surface), semi-buoyant, light and adhesive, heavy and adhesive, and heavy and non-adhesive.

55. Do fishes change sex?

In captivity, old females occasionally take on secondary male characters. In Trout, an old female sometimes develops the hooked jaw which characterizes the male. A female Guppy may develop the colors of the male and even the gonopodium, and in this case "the sex glands may contain both ovarian and testicular tissue, and it is possible that by suitable crossing the sex alteration might become total." (Bibliography No. 178.) But primary sex changes are rare. Essenberg, however, describes complete changes from female to male in the Swordtail (*X. helleri*) which may occur in young specimens or in those that have produced young for over two years. Mothers in the latter case may be mated to virgin females and become fathers; and the offspring will exhibit the sex ratio typical of the species. In Fighting Fishes and Paradise Fishes, also, complete sex reversal from female to male has occurred. Occasionally females of other animals, such as frogs and toads, also fowl and pigeons, change to male. (Bibliography No. 151.)

56. Why and how does the female Swordtail change sex?

The exact cause is not determined, but according to Essenberg it is not due to tuberculosis or other disease and any agent or condition which tends to decrease the capacity for hormone secretions becomes an immediate factor in sex reversal."

Internally there is an actual change from ova-producing to sperm-producing organs. Externally the anal fin is transformed into an intromittent organ. A sword is formed from the ventral lobe of the tail fin and the fish is indistinguishable from a male except for the shape of the body.

57. Does hermaphroditism occur among fishes?

Yes, it has been discovered among many fishes, including Herrings and salt-water Killies.

58. Can a fish drown?

All Labyrinth fishes rise to the surface for air and will drown if not provided with an air space, their gills being unable to extract a sufficient quantity of oxygen from the water; but if their gills become entirely dry they will die, i. e., they cannot live wholly on air.

It is advisable to leave plenty of space between the surface of the water and the cover.

59. What emotions does a fish exhibit?

At least 13 kinds: anger, curiosity, fear, greed, pain, pleasure, jealousy, pugnacity, play, selfishness, sexual emotions, parental emo-

tions and social emotions. We hesitate to add gratitude, but it is well known that some of the larger fishes appreciate having little fishes pick off their parasites, and some aquarists believe that in return they do not molest their benefactors.

60. What degree of intelligence have fishes, and how is their psychology summed up?

All are not as keen as the "wary Trout," but many learn where danger lurks, where food is to be had, where choice resting places exist, what foods are pleasing, the gestures of the people who feed them.

Very few fishes learn to avoid a hook. At a Japanese Goldfish farm, Miss Mellen observed the young son of the proprietor amusing himself with a hook and line which he dropped (without bait) into a pool containing a common Carp about eight inches long. When the fish was captured the boy returned it to the water and it swallowed the hook as often as this was cast into the pool.

The psychology of the fish, like its physiology, indicates that it is at the earliest beginning of the higher vertebrate life. Fish memory and educability are limited, but fishes grow accustomed to their environment and are bewildered when it is changed. Many a fish that has done well for years in one aquarium has died soon after transference to another, unless the new one is more spacious. Some, however, will leave unsatisfactory quarters, and it has been observed in public aquariums that Eels and others may forsake one tank and select another, several tanks away, to which they will journey repeatedly if returned to the first tank. It is not impossible that they are choosing companions with whose physical emanations they are in harmony. (See No. 245, Par. 2, and No. 819, Par. 3.)

Judged by standards of human psychology (the only standards we have) we find species of fishes that are jealous, fickle, rude, assertive and grasping. Among the nest builders there is a pronounced sense of proprietorship, also a masculine superiority complex and an utter inconsistency in encouraging the growth of other lives and then gulping them down. Feminine drabness and infant cannibalism are almost universal. Fishes attack companions in distress and some murder rivals.

61. What do the scientific names of a fish mean as, for example, *Mollienisia sphenops*?

The first is the generic name, that is, the name of the genus; the second is the specific name, that is, the name of the species.

When another is added, as *M. sphenops vandepolli*, the third refers to the subspecies, form or variety, and usually is so designated, thus: *M. sphenops*, var. *vandepolli*. In strictly technical works, it is a deferential custom to add the surname of the person or persons who gave the fish its scientific names, as *Mollienisia sphenops*, var. *vandepolli*, Van Lindth de Jeude. (In this popular work, we are sparing the reader the strain upon his patience.)

62. What is the difference between a variety and a variation?

The word "varieties," which should be applied only to animals representing subspecies, often is wrongly used in referring to those which are only variations.

Dr. Hubert B. Goodrich, of Wesleyan University, says: "A population of animals of a definite species and which exhibits as a group fairly uniform characters distinguishing it from the remainder of the genus, and which breeds true for these characters, is called a 'variety.' A variety is essentially an incipient species and usually has a fairly definite geographical distribution."

When an animal or group of animals shows a deviation in color pattern, structure or function from others of the same genus and species, but does not breed true in nature, it is called a "variation," or, sometimes, a "variant."

Mr. H. Walton Clark, of the California Academy of Sciences, says: "'Breeds' is perhaps the best term for aquarium forms developed by artificial selection."

We have, for example, the many breeds (or variations) but 1 varieties of fancy Goldfishes, which, if left to themselves, revert to the form and color of their wild ancestors. The same illustration may be applied to the various breeds of Platys, Fighting Fishes, Guppies and others.*

63. What is the scientific system of naming called?

Nomenclature, or more frequently, scientific nomenclature. The binomial (two name) system was laid by Linnæus in 1753. With a third name it becomes trinomial.

64. Why is it necessary to have Latin and Greek names for fishes?

In order that a person in any part of the world may know what fish is being referred to, regardless of what language he himself may speak.

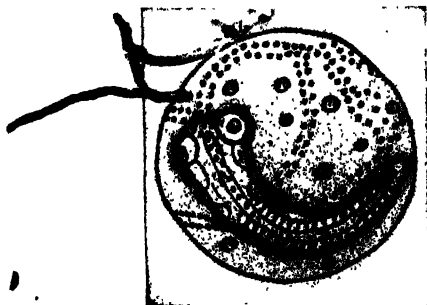
* We are indebted to Dr. Goodrich and Mr. Clark for kind assistance in presenting a correct answer to this difficult question.

65. Why are the scientific names of fishes changed so often?

To settle early disputes, priority of naming was made the determining criterion, with the result that even though no dispute is involved, names are changed whenever anyone discovers that a name different from the one in use was bestowed on the fish by some earlier writer. The newest scientific name therefore is the one believed to be the oldest. Thus common names become increasingly important for without them it sometimes would be impossible to discover the "latest" scientific name, as this may change with dizzy frequency.

66. What is a fingerling?

Infant fishes are designated first as embryos, before birth and also while carrying a yolk sac, then as fry. Later, and while no longer than a man's finger, they are called fingerlings. (Pigmy fishes are called adults when they mature, even though only half an inch long.)



Drawn from life by Ida M. Mellen

How the embryo looks in the egg. Three days after fertilization the egg of the Common Killie or Mummychog (*Fundulus heteroclitus*) shows the little fish lying on the egg yolk, while circulation of the blood has begun. The smaller cells forming into regular, jerking little chains across the yolk and through the embryo are blood corpuscles, the larger cells oil globules.

67. What is an albino?

An albino is an animal lacking pigment in skin and eyes (also in the hair in mammals) and can be produced only when the trait is carried in the germ cells of both parents. Albinos are found among all groups of animals, from fish to man, but although albinos for pets and exhibitions are greatly in demand, albinism in nature is not a desirable trait, rendering the animal conspicuous to its foes, which its poor vision prevents it from seeing. The pink eyes are sensitive

to light and an albino fish best observes food thrown into the tank at an angle.

Under the laws of Mendelian inheritance, albinism is called a recessive trait, the expectation being that only one in four offspring will be albinos if the parents are normal but of albinic stock. If both parents are albinos, however, all the offspring may be expected to be albinos. If one parent is an albino, the other normal and not of albinic stock, all the offspring will be pigmented. That is why it is so difficult to produce an albino strain by artificial selection.

68. What is meant by a "sport" when referring to animals?

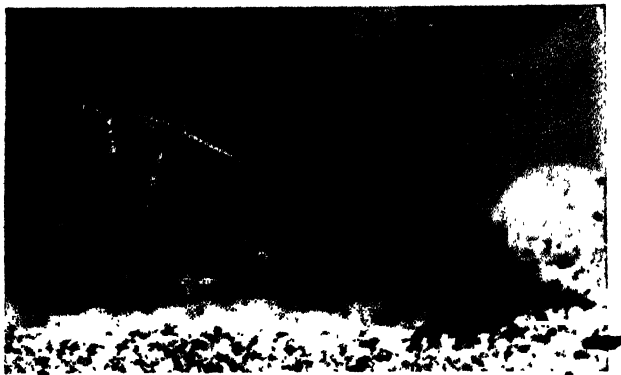
An animal which represents a sudden and spontaneous departure from the normal type. Called also a "biological sport."

69. Is a hybrid a sport?

No. Hybrid is another name for mongrel or half-breed. A hybrid is the offspring of parents of two distinct species, breeds or genera.

70. What work has been done in hybridizing?

Many toy fishes have been interbred, including such egg layers as Danios and Barbs, and such live-bearers as Guppies, *Limias*, Mollies, Platys and Swordtails, with interesting results, especially interesting to the biologist because the progeny frequently are fertile, which is against the expectation, particularly where the crossing is of distinct genera.



Courtesy John G. Shedd Aquarium

Hybrids

Hybrids resulting from matings of the Blue Moonfish and Mexican Swordtail are of various colors. Those shown are red (upper) and black (lower).

The hybrid *Mollienia* known as *formosa* is produced by crossing a female *M. latipinna* with a male *M. sphenops*.

The Orange *helleri* is produced by mating a male Golden Platy with a female *X. helleri*. The Red *helleri* is the result of a cross between a male *Platyopocilus maculatus* (Red) and female *X. helleri*. The Black *helleri* is produced by crossing a male *P. maculatus* (Black) with a female *helleri*. The female Red *helleri* can be crossed with a Swordtail and a large percentage of the young will prove fertile.

Hybridizing has been discouraged by some aquarists because of disappointments when the offspring of hybrids are not true to type. Red *helleris*, too, have been confused with Montezumæ Swordtails and sold for such.

If one is determined to experiment, however, a knowledge of the laws of Mendelian inheritance is advisable, and these are not the same as in the case of albinos.

Each offspring of a black and a red fish would be expected to show the colors of both parents. The offspring of these hybrids would show out of four fry two like themselves and one like each grandparent.

The same rule would apply to the fourth generation, as the two that are like the hybrids would, if intercrossed, produce out of four fry two like themselves and one like either parent of the original stock. But if the offspring in the third generation which resemble one or the other grandparent be bred with offspring precisely like themselves, they will breed true.

Crossing of separate species or genera will bring out dominant traits in hybrids, as size, color, physical and psychological peculiarities, which will appear in their hybrid type offspring in a ratio of three out of four.

71. Is specie the singular of species?

The singular of species is species. The word *specie*, not infrequently met with on the labels of aquaria at public exhibitions, refers to coined money and not to the animal kingdom. (Its use is most astonishing when coupled with laboriously correct Latin and Greek names of fishes.)

72. What is the plural of fish?

Fish in the pan, *fishes* in the water or preserved in a museum.

73. Will fishes stand petting?

Generally speaking, the theory that the less a fish is handled the better it will be for its health, is a good one. A fond lady took

her Goldfish out of the aquarium every morning to kiss it and wondered that it should die from over-affection. On the other hand, old and tame Goldfishes at the Bruce Goldfish Fisheries enjoyed being stroked. The Tarpon, which is a fearless fish, will permit itself to be stroked. Some fishes become very tame when they have eggs in the nest. Thoreau, in 1849, discovered that he could stand astride of the nest of a Common Sunfish, stroke the fish on the back and feed it from his hand. Reighard states that in this species the fish may even be lifted from the water in the hand, and when it is returned it will resume its parental duties.

Rainbow Darters have become tame enough to swim into their owner's hand and Sea Horses will swim into anyone's hand, but the Sea Horse wears a coat of mail and is in no danger of having its scales injured. Most fishes are easily tamed, some never make human friends.

When naturally shy little fishes like Rainbow Darters confidently swim into the human hand, they may rightly be called pets.

74. Does a fish need company?

Some fishes naturally are solitary, but a majority are social animals and therefore happier in company with other fishes. Probably they are happiest when schooling with their own kind.

75. How long do fishes live?

More extensive work in lepidology, the study of the scales of fishes, on which the age is based, is needed before this question can be answered. Fishes are built for longevity, but as animals, in nearly every group from protozoa to man are their enemies, they seldom reach their life span.

Fishes that swim and eat at the surface appear to be those with the shortest lives, at least they die quicker upon removal from the water, as Dace, Maclurel, the Butterfly (*Pantodon*); and those that live and feed near the bottom appear better to resist drying up, as Carp, Catfishes, Tench, Eels, Flatfishes, Mud Minnows. It is well known that Goldfishes live for more than 25 years. Eels and wild Carp for more than 40 years. Major Stanley S. Flower cites a record of 60 years' survival in the European Catfish (*Silurus glanis*). Among fishes which have been maintained in captivity, those which mature early and spawn frequently appear to be the shortest lived.

Following are a few reports which may or may not be correct. We are unable to verify them:

A Trout placed in his well in Westmoreland by a Mr. Hossop, is



*Photograph by William I. R.
Cortsey Buffalo Museum of Science, Buffalo, N. Y.*

Pets

When naturally shy little fishes like these Rainbow Darters confidently swim into the human hand; they may rightly be called pets. The Darters shown in the photograph were tamed by Miss Annabel D. Galvin.

is said to have come to the hand of his son to be fed for 53 years and died during a drought when the spring feeding the well dried up.

Studies of scales of Halibut are said to prove that at 100 years a Halibut is only in its infancy and may live yet another century.

In 1497 a Pike was caught in a lake near Heilbronn in Swabia with a brass ring attached to it recounting that it was placed in the lake in 1230.

The ponds of European monasteries and the moats of feudal castles have been reported to contain marked specimens of Loaches which have lived 260 years and Carp 375 years.

76. Why do some fishes prefer soft plants and others chew up fishes, bones and all, as well as crustaceans and mollusks?

The selection apparently depends partly on the depth of the water they inhabit, i. e., the foods available in their immediate surroundings, but principally on the character of their teeth, which may be sharp for chewing flesh, blunt for crushing shells, weak or lacking and necessitating soft foods. (Bibliography No. 216.)

77. Why are fishes and snails sometimes found dead in aquaria and garden pools after an electric storm?

We do not know. A snailery standing on the inside sill of an open window in a city apartment house contained only dead snails (red Copenhagen variety) after a thunder storm, and Goldfishes and other species may be found dead at the surface of the water in outdoor pools after such a storm. To quote Mr. Frank T. Bell, United States Commissioner of Fisheries:

"There is no scientific explanation of the phenomenon. There have been several instances in our hatcheries when numbers of fish have been found dead after electrical storms, and although no proof can be shown for the assumption that they were killed by lightning, there seems to be no other explanation."

78. What is the best way to preserve a prized fish that has died?

A 3% solution of formalin (formaldehyde) will hold the colors better than alcohol, but the fish must be placed in the solution immediately after death, as fishes' colors fade when they die. Formalin destroys bacteria, but it has the effect of hardening the tissues, and for this reason it is necessary to arrange the fins before putting the fish into the solution. As a rule, fresh-water specimens bleach out quicker than salt-water specimens.

SHIPPING FISHES

79. Do fishes suffer from seasickness?

Not in a natural state, but they suffer from seasickness and car sickness when rocked in shipping cans unless traveling on empty stomachs. It is customary to withhold food for the week prior to shipment.

80. Should aeration be supplied when shipping fishes a long distance?

This depends upon the number of species in the container, their kind and size.

81. What type of container should one use when shipping northern native fishes or Goldfishes?

A shallow container of large diameter with a narrow top is preferable to a narrow, deep container.

82. When shipping a large number of containers having fresh- or salt-water fishes, which method is best?

Water circulated and filtered is best when it can be arranged. (Bibliography No. 199.)

83. What is the best way to supply oxygen or compressed air when transporting fishes a long distance?

Use a releaser that will give off a very fine spray. Avoid large bubbles. Do not allow too much oxygen to escape through the releaser into the water.

84. When is the best time of the year to ship tropical fishes?

In the eastern states, July and August, and sometimes during September; in the western states, June to December. Insulated containers should be used.

85. How many tropical fishes will a one gallon thermo jar carry with safety?

Fourteen one and one-half to two inch fishes can be carried with safety if personally conducted and aerated by frequent lifting of water with a dipper and pouring back slowly.

When in transit for four days or more, aeration for 10 minutes every three hours will be sufficient.

86. Should the water be changed when tropical fishes are being shipped a long distance?

No, this is not necessary. If more water is needed, add about one pint to each gallon, being careful that the temperature is not changed too rapidly.

87. How can fishes be stimulated when weakened by a long journey?

A bath in a solution of one tablespoon of sea salt to a gallon of water for 15 or 20 minutes will stimulate them. Professional shippers commonly place a little salt in the shipping cans.

88. Are fishes killed by concussion during shipment?

No. Mr. Lanier has observed, in transporting fishes, that though they may be subjected to violent concussion when the cans are struck, badly frightened and even stunned by being thrown against the sides of the cans by the jolting of the train, yet they usually make a complete and lasting recovery.

THE FRESH-WATER AQUARIUM

89. When were fishes first kept in glass or other receptacles?

This question cannot be answered with exactitude. Before 300 B. C. the Egyptians made opaque glass which was not blown but molded over cores which were later ground out. After 300 B. C. blowing of glass was invented and glass was fairly clear, but no evidence exists that this early glass was used for aquaria.*

Egyptians may have kept some of the gorgeous Egyptian toy fishes in glass vessels before Christ, and prehistoric man may have kept tiny fishes or other water creatures in clay bowls more than 10,000 years ago.

According to Koh, a Chinese scholar of the present day, Goldfishes of China were cultivated in vessels instead of in ponds during the Ming Dynasty (1368-1643).

There is some evidence that small native fishes were kept by private individuals in England about the time that Madame de Pompadour in France was enjoying her rare gift of Goldfishes.

90. What is a vivarium?

Vivarium is a very old word, yet one seldom used except in print. Bailey's English Dictionary of 1755 defines the vivarium or vivary as "A Place either of Land or Water where living Creatures are kept; a Park, Warren or Fish-Pond." Shirley Hibberd in 1856 defined the vivarium as "An imitation of the means employed by nature herself in the preservation and perpetuation of the various forms of animal and vegetable life which people the oceans and streams," thereby limiting it to the salt- and fresh-water aquarium to which others of the 19th century applied the term "aquavivarium," but dictionaries of today revert to Bailey's definition. Vivarium therefore may mean for the nature lover of the 20th century either an aquarium or a terrarium.

91. What are the first points to consider in setting up an aquarium?

The size and shape of the aquarium, best light for it, gravel, plants, fishes according to kind and number, scavengers, water, foods and necessary implements. (All these questions are answered here.)

* This information is kindly supplied by Mr. Ambrose Lansing of The Metropolitan Museum of Art, Department of Egyptian Art, New York

92. What size should a home aquarium be?

The largest you can afford and accommodate. For Goldfishes and native species, from eight gallons up; for tropicals, from five gallons up, though very small tropicals and small air breathers do well in aquaria of one gallon or less.

93. Name some of the points in favor of the larger tank over the smaller one.

The larger tank prevents rapid temperature fluctuations, is favorable to plant growth, lessens the danger of pollution, enables the keeping of larger numbers of fishes and speeds their growth. The fry of toy tropicals whose parents are cannibalistic, have a better chance to escape in the large aquarium.

94. What is the best kind of aquarium for the fishes?

All glass, straight sided, if procurable, or metal frame rectangular. The latter is not as easily broken. A square tank distorts and the same surface area can be gained in a rectangular tank of the proper dimensions. The Goldfish bowl is suitable only for fry, and is very convenient to have in reserve for this purpose. For larger fishes it is useless. It distorts the image, the surface exposed to the atmosphere is too small and the danger of overcrowding is very great. The most practicable tank is a moderately large one, rectangular, of not less than 10 gallons' capacity. As large a surface area as possible is desirable. Glass drums and other small aquaria with large surface area are suitable for fishes of very small size.

95. How can one determine the capacity of an aquarium in gallons?

Square or rectangular: Multiply the length in inches by the breadth and this by the height. Divide the total by 231.

Round: Multiply the square of the diameter (in inches) by the height and this by .0034. (To square a number, multiply it by itself.)

96. What is the simplest way of determining the weight of the water in the aquarium?

Multiply the number of gallons by eight and one-third, which gives the weight in pounds.

97. Is it best to build one's own aquarium?

Few people now construct their own aquaria, those on the market being handsome, durable and inexpensive; but direction

are given here for the construction of iron frame aquaria for any who may desire to build their own. Or tanks may be built of wood.

The frames of those on the market are constructed of iron and brass, some chromium plated, or of rust proof steel, Allegheny metal or other non-rusting alloys. •

HOW TO MAKE AN IRON FRAME AQUARIUM TANK

98. How can one construct an iron frame tank for keeping fishes in the home?

Shape and size: A rectangular tank will be found the most serviceable for fish life. A tank of 18 gallons' capacity is a very satisfactory size. This should measure 24 inches long, 12 inches wide, and 15 inches high.

For the frame: Galvanized sheet metal of 14 gauge is the right material. Unless one is equipped with proper tools, it is difficult to bend this sheet metal at right angles and therefore best to have it bent in lengths to a one-inch angle by a sheet metal worker.

When the angle has been made, it should be mitered at the corners or cut to the required length for soldering (making two frames 24" x 12" x 15", one for the bottom and one for the top of the tank). If one does not wish to miter the corners, they may be cut to the required length and lapped. A mitered job, however, makes a neater tank. When soldering the corners, make a smooth joint or it will be necessary to file off high spots on the inside of the completed frame before setting the glass. Next cut four pieces of the one inch angle for the uprights, 14 inches long. Now solder these uprights to the rectangular frames previously made. In soldering the uprights in place much trouble will be avoided if clamps are used to hold them after they are lined up squarely with the sides and front of the frame. In the same manner solder the remaining frame to the uprights. In order to reenforce the bottom frame at the four corners a flat right angle piece of metal (1" x 2") should be soldered flat on the bottom.

The frame of the aquarium will now be complete and ready to receive the bottom, which can be of metal, slate, or wired glass. Three-eighths inch slate will be found most satisfactory for this purpose.

To cement: Aquarium cement may now be placed all around the bottom of the frame so that it is nearly one-quarter inch thick. Then place the slate bottom in position, using equal pressure on it until there is about one-eighth inch of cement between the bottom

1001 QUESTIONS ANSWERED

frame the slate. Trim off all surplus cement and mix with original batch to be used for setting the glass sides.

It is advisable to cut the glass so that room will be left to remove one side, should it be broken, without disturbing the other sides.

To set the glass: The ends now may be set. Apply the aquarium cement around the frame, one end at a time. When both ends have been set, apply equal pressure so the cement will be forced out evenly all around the frame and have at least one-sixteenth inch of cement between the metal frame and the glass. Now place a flat piece of wood about seven-eighths of an inch thick, four inches wide and 12 inches long on the inside face of each end and brace between these ends with another piece of wood to hold them in place while putting in the front and back glasses. Next set the front glass, then the back, in the same manner, and trim off all surplus cement. When all glass is in place, fill with water and allow to set for a day or so. Before draining, trim off all cement that has been squeezed out around the frame by the water pressure.

To paint: Let dry thoroughly before painting. If a metal bottom is used, paint with two coats of black asphaltum varnish (turpentine base) and allow to dry for another day or two. Your tank then will be ready and should last for many years.

99. What kind of wood is best for making aquarium tanks?

Cypress and white cedar are best, and should be conditioned or "seasoned" before fishes are introduced, by soaking it for three days, then emptying and refilling for three days more, and repeating this procedure over a period of three or four weeks.

100. Can fish tanks and garden pools be painted green?

One aquarium manufacturer says that chrome green (powdered) can be mixed with the cement, and when the tank or pool is dry it can be filled repeatedly with water for a few days and then allowed to stand six weeks, when it will be safe for the introduction of fishes. Another expert says that paint may be mixed with boiled linseed oil and left until thoroughly dry, when the tank or pool should be filled with water and allowed to stand for a week or 10 days, after which it should be thoroughly washed out several times, and then will be harmless to the fishes. Of course a pool can be tiled green if desired.

CARE OF THE AQUARIUM :

101. How should the aquarium be sterilized?

The glass should be washed with a salt solution and the aquarium rinsed thoroughly with strong salt water, one cup to the gallon, or allowed to stand one hour with a strong solution of permanganate of potassium of a rich red color. All traces of chemicals should be removed before introducing fishes, pebbles or plants.

102. Should one use pebbles, gravel or sand in a tank with plants and fishes?

For larger fishes pebbles may be used, for smaller fishes sand or gravel, which should be washed first in boiling water. Pebbles have gone largely out of fashion because fishes habitually clean their gills with fine sand; also because pebbles afford pockets for uneaten food.

If sand or gravel is used, it should be at least two inches deep. Two and one-half inches is better.

Gravel about one-sixteenth of an inch will be found excellent for the aquarium of average size. Gravel of larger size may be used for very large tanks, but it makes it more difficult to remove uneaten food.

If the sand or gravel is high at the back of the tank and lower at the front, it will cause any sediment in the aquarium to gravitate toward the front where it can be easily siphoned out.

A little earth now and then also is an excellent thing. All small aquarium fishes enjoy earth and appear to gather food substances from it.

103. How should plants be sterilized and placed in the tank?

Plants should be sterilized before introduction into the aquarium by placing them in a pink solution of permanganate of potassium for ten minutes. Use two grains, by weight, to the gallon of water. After disinfection, the plants should be rinsed thoroughly under the faucet and metal clamps removed from their roots. Fill the tank half full. With the finger press a hole in the pebbles or gravel and insert plants, packing the gravel firmly around the roots. When the plants have been set, add the remainder of the water by pouring it from a pitcher onto the hand held low over the plants, or into a small pitcher or rose bowl set on the bottom of the tank, or distribute it evenly over the surface from a watering can. This prevents uprooting.

104. How soon should fishes be introduced into the aquarium?

Not until the aquarium has stood for at least a week after being set up, to allow oxygen bubbles to break up and plants to become habituated. Sterilize the fishes first. (See No. 106.)

105. Is old water a valuable medium for the normal fish?

Not as valuable as claimed. Excellent for a very sick fish to be deposited in and left alone for a few weeks.

106. Should fresh-water fishes be sterilized?

Fishes never should be introduced into a healthy aquarium without first being quarantined for a week or ten days and carefully observed for traces of disease. Sterilize them in a mild salt-bath, one teaspoon to the gallon of water for 24 hours, and repeat this operation three days later. Another method is with potassium permanganate which can be bought weighted by grains. Make a solution of one grain by weight to the gallon of water, immersing fishes for 15 minutes twice a week during quarantine. If a stronger solution seems in order, use two grains by weight to each gallon of water and immerse the fishes for 10 minutes.

107. What is a weak solution of permanganate of potassium?

One which allows us to distinguish at 12 inches an object such as a white pebble on the bottom of the tank. Fifteen minutes is the right time for immersion in this kind of bath. (See preceding question.)

108. How many fishes should one introduce into the aquarium?

The great fault of the amateur is in buying too many fishes at the start. For Goldfishes and northern native species there is a definite rule of one inch of fish to each gallon of water. In the case of a community tank for toy tropicals, a well-planted 10 gallon tank will accommodate as many as 24 of the smaller kinds. A larger number of fishes can be maintained in a balanced aquarium with artificial aeration, or in a circulated aquarium in the case of Goldfishes and northern native species.

109. What is the best way to replace water lost by evaporation?

With a small watering can. This disperses it evenly over the surface, or it can be poured onto the hand or onto a paper or light tin plate to prevent uprooting plants.

110.-Is it safe to use soap when cleaning an aquarium?

Soap should not be used. Ordinary salt and warm water will do. This solution, with the aid of a safety razor blade, will remove any foreign substance from the glass.

111. How often does an aquarium need resetting?

Every six months for Goldfishes or native fishes. Four or five years for toy tropicals. Otherwise the water need not be changed unless it becomes foul from dead fishes or snails or decaying food.

112. What is the proper way to introduce the fishes?

They never should be dropped into the water, but allowed to swim out of the container by placing it at the surface and tipping it gently to permit their exit. It is wise first to test the water they are in and if necessary add water from the aquarium to accustom them gradually to the temperature and quality of the new medium.

113. Should the aquarium be covered?

It is customary to cover the tropical toy fish aquarium with a close fitting cover glass to conserve heat and protect against the loss of Butterflies and other fishes which have a habit of leaping. Other aquaria are provided with a glass top set on cork strips one-quarter inch thick to admit air, keep out dust, and prevent the fishes from jumping out. (See next question.)

114. What is the principle of the balanced aquarium?

The principle of the balanced aquarium was given by Butler in 1858 as follows: "Animal life absorbs oxygen and throws off carbonic acid gas. Vegetable life, on the other hand, absorbs carbonic acid gas and throws off oxygen. What one rejects the other needs." This definition still holds with all experienced aquarists.

Of recent years the fact that plants consume some oxygen at night has agitated some of our amateurs who argue that plants are therefore of no value whatever except for beauty.

This theory does not harmonize with the success which toy fish breeders have with aquaria on which a tight fitting cover glass is used. It overlooks the pH values of plants and their benign effect upon the fishes, exhibited by busy interest and sustained color; and it repudiates "good old Mother Nature."

A fish, it is true, can live without plants, and so can human beings live in a room without furniture.

Chemically, therefore, the aquarium may be balanced without

plants. Esthetically and for the good of the fishes, it can not. The importance of air, however, is not overlooked by practical aquarists who believe that when the proportion of plants, fishes, water and air is just right, fishes and plants will thrive and remain healthy. That is to say, they balance, and mechanical aeration is unnecessary. See Nos. 117 and 160 for importance of light in this respect. (Bibliography No. 217.)

115. Who discovered the early principle of the balanced aquarium?

The balanced aquarium was a gradual development of many minds, among whom may be mentioned Priestly (discoverer of oxygen in 1774); Ingenhousz (experimental philosopher and physician) 1778; Daubeney (chemist) 1833; Ward, 1837; Johnston (Scotch naturalist) 1842; Lankester (physician and scientist) 1849; Warrington, 1850. But Gosse (English zoologist) in 1852 "perfected all the labors of his predecessors."

116. What are the essentials for success in maintaining a balanced aquarium?

Proper light, proper medium, sufficient swimming space, plenty of oxygen, and nourishing foods.

117. What constitutes proper light?

Daylight the year round, and a touch of sunshine in winter, say an hour a day for North America. The most desirable window is one having northern or eastern exposure. In too strong light the aquarium suffers from an excess of algæ. In much limited light the plants do not thrive. If circumstances necessitate placing the aquarium in a south or west window, it should be shielded with a strip of cardboard or painted glass while the sun is shining on it. If it is necessary to set the toy fish aquarium in a drafty spot, near a window or open door, thermostatically controlled heaters may be used to prevent drastic fluctuations in temperature.

The most important point concerning light is that there must be enough to cause the plants to throw off sufficient oxygen both for their own consumption by night and for the use of the fishes.

118. Can an aquarium be maintained under electric light?

Yes. A clear bulb is more efficient than a frosted one. Ten hours a day will be found adequate, with a maximum of 12. Mr. Lanier has found that two 50 watt lamps over a tank 24 inches

long are very effective where daylight is completely absent. The light source should be at the top of the tank toward the front. This gives a better effect and the colors of the fishes are seen to better advantage. Reflectors produce better lighting and should be used to screen the light from the observer's eyes. If sufficient light is used, aquatic plants will grow, though not as rapidly as under natural light, and after a time they will deteriorate. Artificial light must be controlled like natural light. *Vallisneria* grows exceptionally well under electric lighting. *Sagittaria* and *Anacharis* do best in the brightest exposure, but *Cryptocoryne* and *Fontinalis* do better where the light is not so bright.

119. What is meant by proper medium?

The temperature and the quality of the water. The salts, lime and acids of natural ponds can be replaced in the home aquarium by an occasional pinch of salt, together with a very small pinch of bicarbonate of soda, also by grated cuttle bone and by plaster of Paris first hardened with water, or by calcium phosphate.

Lumps of salt, lime and soda composed of the following parts can be prepared and kept on hand:

6 full tablespoons calcium sulphate (plaster of Paris) or 5 of this and 1 spoon of calcium phosphate

2 full tablespoons Turks Island salt (or bath salt unadulterated)

$\frac{1}{5}$ tablespoon bicarbonate of soda.

Calcium phosphate neutralizes acids quickly, but will not remain lumped in water unless combined with plaster of Paris.

Stir well and use enough water to mix and harden.

To avoid disease among one's fishes, one must keep the water of the aquarium as pure as possible. The element fishes live in is of prime importance. Often it has been said that a man is what he eats. As truly it may be said that a fish is what it drinks.

Foul water, sudden changes in the temperature and character of the water, overcrowding and allowing food to accumulate, create trouble in an aquarium.

120. What does sufficient swimming space mean?

It means that most fishes cannot endure cramped quarters. Their well-being depends on plenty of exercise. Slender bodied fishes, which include most toy tropicals, can get along with less water than Goldfishes (see No. 108), but all should have room to swim.

121. How can plenty of oxygen be provided?

First by providing an aquarium with a large surface area. Many amateur aquarists use mechanical aerators for tropicals. It is easier to place too many animals in an aquarium than to introduce too many plants, yet an excess of plants may render the water too alkaline when in bright light, and in the dark may render it too acid. Too many plants also restrict the activities of the fishes.

122. Is it advisable to add fresh water to the old aquarium occasionally?

Additions of fresh water will be found beneficial, provided the temperature of the old water is not changed too much.

123. Does aquarium water absorb gases in the room?

Yes, fishes in aquaria suffer from poisonous gases such as those given off by smelters, from ether in hospitals, and from carbon monoxide gas from automobiles and burning tobacco. Smoking in the room will not injure the fishes if a window is open, but ashes or cigar stumps falling into the water speedily prove fatal—a mere scrap of tobacco containing enough nicotine to kill a large number of fishes.

124. Are fumes from paint or lacquer injurious to fishes in a balanced aquarium?

Yes, very injurious, particularly so if the water is agitated, the breaking of the elastic surface film causing the fumes to penetrate more quickly. Also, if the surface water is cooler than the layers below, the fumes naturally will go to the bottom in what is called a convection current. Even if the surface film is not disturbed, the fumes of paint and lacquer, carrying air dust, descend on the water and form a dangerous layer, preventing the interchange of gases between air and water which is necessary for the well-being of the fishes.

Fishes become affected in from 36 to 48 hours.

125. Of what does aeration consist?

Aeration consists of an effort to displace carbon dioxide with oxygen, and this is true whether accomplished with the tiny fin of a fish fanning its eggs or with elaborate machinery.

Older methods were to dip out water from the aquarium and allow it to fall back slowly, gathering oxygen as it dropped; also

to soak a sponge and suspend it above the aquarium to introduce oxygenated water in drops.

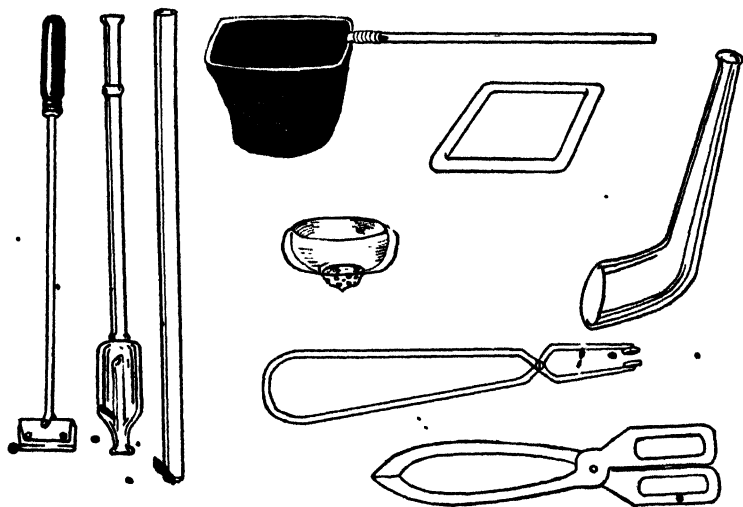
More modern methods are to introduce compressed air or oxygen directly into the water by releasing it in a fine spray, or by circulation.

The aeration of marine aquaria by mechanical means has been understood for more than 50 years. (Bibliography No. 4.)

126. What aquarium implements are necessary?

One needs the following implements:

A glass lifting or dip tube or a rubber siphon to clear the bottom of the tank of debris and uneaten food. The best glass siphons are the boiler tubes sold in hardware stores and the gauge glasses sold in machine shops. A good rubber siphon is a piece of rubber tubing three-eighths of an inch in diameter and 36 inches long, or



Aquarium Implements

Drawn by Cecil Tose

Left to right: glass cleaner, dip tube with bowl, and dip tube of the eighth inch glass. Top, center: fish net. Below it at right: glass feeding ring. Center: white worm feeder. Extreme right: glass net for catching baby fishes. Below, center: planting tongs. Right: planting tongs of wood, used in salt water.

longer, used with a glass tube of smaller diameter than the hose. This glass tube is inserted in the end of the rubber tubing and should be about the depth of the aquarium. Two inches less is still better, as it will not kink the hose.

A safety razor at the end of a stick to keep down the growth of algae on the glass. Cuttle bone may be employed for this purpose and will not scratch the glass.

A small net to remove dead fishes or snails, but it is much better for the living fishes if their scales do not come in contact with a net unless it is made of curtain scrim or other unknotted cloth. Knots tear off scales. Another point to remember in handling fishes is that their eyes have no lids and are liable to injury and infection from the pressure of the net or the touch of a hand. A large spoon or cup is advisable for transferring small fishes from one tank to another.

A long-handled forceps for embedding new plants, supplemented by a smooth stick of equal length.

A glass feeding ring. One glass feeder is made in the form of a funnel with a long tube through which the dry food descends to the bottom of the tank. Smooth glass bars partly close the end and prevent small fishes from entering.

A thermometer and an aerator; and for live-bearing toy tropicals, a fry trap is a desirable accessory.

Many aquaria now are equipped with filters, also special feeding areas enclosed within glass or stones at the center or one side of the tank, sand, pebbles and plants being kept out of this area so that all uneaten food may be observed and removed.

127. How is aerator pronounced?

As spelled, —ā'-er-ā-tor. Not air'-ē-ā-tor.

128. How often should the sediment be siphoned from the bottom of the aquarium?

About every week or ten days. The more fish in the tank, the more often it will need siphoning.

129. How is the glass lifting or dipping tube used?

The tube should be about three-eighths or one-half inch in diameter and six inches longer than the depth of the water in the aquarium. It is used to remove particles of food or any object on the bottom of the tank, in the following manner:

The upper end of the glass tube is closed with the finger, the

tube is directed immediately over the object, then the finger is removed and the inrush of water will carry with it the object to be lifted. The upper end is again closed with the finger, the tube is raised to the surface, and the lower end closed by the other hand while the contents are viewed and disposed of.

130. How can one prevent the gravel or sand from being siphoned out when using a siphoning hose?

Hold the glass tube which is inserted in the end of the hose so that it is about three-fourths of an inch above the top of the gravel, and as it is moved above the debris, this will be sucked up. Should any pebbles or other objects be sucked into the glass tube, the hose should be pinched, thus stopping the flow of water, and the particles will drop back.

131. What is a breeding or fry trap?

A container hung inside the aquarium to confine the female live-bearer, though large enough to permit her to move about freely. Small openings at the bottom and sides are arranged, through which only the new-born fishes can pass into the aquarium. Thus they are saved from being eaten.

132. What causes the sand in an aquarium to turn black?

Unconsumed food or any other decomposing organic matter causes this condition. All dead plants and animals should be removed as quickly as discovered.

133. Why does a film appear on the surface of the water in a balanced aquarium?

It is caused by lack of oxygen, accumulated dust, bacteria, and gases from decomposing plants and animals. This film is not necessarily injurious to fishes. It may contain microscopic organisms valuable as food, but it is unsightly.

134. How can one remove the oily surface film?

An old method of removing surface scum is by floating it off on bits of newspaper. Or, an absorbent paper napkin may be floated, and when soaked, lifted off. The film will adhere to it. Another method is to use a narrow strip of cardboard the width of the tank, crowd the film to one end and skim it off. Much will adhere to the cardboard.

135. Should the fluffy brown sediment at the bottom of the tank be removed?

If the water in the tank is clear, this sediment (mulm) should not be removed unless it is more than one-quarter of an inch deep. When the tank is cloudy and the sides and bottom show a film of slime, then it should be cleaned out.

136. What causes bubbles to arise from the sand at the bottom of the tank?

When gaseous bubbles are rising, it is a warning that decomposition is going on. Usually this means resetting.

137. What causes milky water in the aquarium?

Failure to remove uneaten food or dead animals which are decomposing and swarming with bacteria. If the bottom is siphoned off, the condition may clear in a few days. Otherwise the aquarium must be reset.

138. What is the cause and cure for green water in the aquarium or garden pool?

It is caused by a tiny floating plant called alga (al'-ga). More than one are called algæ (al'-jee). These plants propagate readily in strong light and in slightly acid water, and fertilizer nourishes and develops algæ.

When the green water is not too thick the fishes like it, but it is not popular with their owner who prefers to view them through a transparent medium. Some aquarists keep a tank of green water in reserve for a hospital. Sick fishes appear to thrive in it.

The green water can be remedied by keeping the aquarium in the dark for a few days, which will kill the algæ, but the dying vegetation is not desirable for the fishes. They may be transferred to another aquarium temporarily and returned after siphoning off the dead algæ. Daphnia eat floating algæ with astonishing rapidity. A weak solution of permanganate of potassium will kill algæ.

139. Do algæ give off oxygen?

Yes, much more than many fish fanciers realize.

140. What causes fishes to seek the surface of the water to breathe?

Lack of dissolved oxygen due to overcrowding or foul water.

141. Why is it that fishes cannot use atmospheric air so well?

The oxygen in the atmosphere is undissolved and the gills are so constituted that they extract only the dissolved oxygen which is in the water.

142. Is spring water desirable for an aquarium?

Many spring waters are not suitable for fishes. Some commercial spring waters may be used where tap water is not suitable and are easily brought to pH 6.4 by the addition of acid sodium phosphate. (As a rule one teaspoon to every five gallons is the correct amount, but an aquarium tester will determine this.)

143. Is Artesian well water suitable for fishes?

If it is hard, it can be softened with bicarbonate of soda. Some Artesian well water is very soft. Some is wholly unfit for fish life where it is deeply saturated with inorganic minerals.

144. Is electrified water suitable for fishes?

It requires the same treatment as spring water.

145. Is distilled water desirable for fishes?

Freshly distilled water is neutral and lacks the organic salts necessary for fish life. It is said to be poisonous to *Gammarus*. Its toxicity can be suppressed by the addition of small quantities of salt if one is chemically minded and wishes to experiment.

146. What effect does chlorine have on fishes?

It has a toxic effect. This dangerous poison has been known to depopulate more than one public aquarium. The fishes usually become restless, breathing rapidly and sometimes losing their equilibrium.

• If chlorinated water is allowed to stand (preferably in an enameled container) for 24 hours, it will be safe.

147. Are metals dangerous in an aquarium?

Brass, copper, zinc, chrome and various other metals are dangerous in an aquarium, having a toxic effect on the fishes. When iron is used in constructing aquaria it is painted or nicked, and brass can be lacquered, or either can be covered with a heavy coat of black asphaltum varnish, which withstands the action of both fresh and salt water.

148. Are ornaments in the aquarium injurious to the fishes?

They may not harm the fishes, but the ideal aquarium is one which simulates natural conditions as closely as possible. Sea shells and corals are best reserved for the salt-water aquarium, and mermaids safely can be relegated to the nursery along with Santa Claus.



Photograph by C. A. Sherman

An aquarium built with rockwork to please fishes' eyes and human eyes. The fishes enjoy hiding in the shadows of the arch, and a mossy covering of green algæ, which naturally forms on objects under water, has converted the stones into a very attractive picture.

and the pixies. When shells are used they should be laid with the opening down so that uneaten food may not accumulate in them.

Stones may be cemented together to form an arch but great care must be taken to cure the cement before placing it in the aquarium. (See *Garden Pools of Cement*, No. 995.) Under the arch fishes play and rest and as it becomes carpeted with green growth (algæ) they discover new browsing places and the effect is pleasing and natural.

Many beautiful minerals are available for the production of

colorful and natural effects—quartz pebbles, black, blue, green and red; Tourmaline, crystal, green, red and yellow; Serpentine, green Prehnite, black Franklinite, Rose Calcite and Salmon Calcite, Feldspar of various colors, colored sandstone and others. Pieces of pink petrified trees also make a fine showing, as well as smooth pieces of colored glass.

SCAVENGERS

149. Is it necessary to have scavengers in the aquarium?

Not if one feeds carefully and does not allow decomposing matter to accumulate. Uneaten food should be removed not later than the day after it is introduced.

150. What are the most desirable scavengers?

Scavengers must be selected according to the character of the fishes in the aquarium, snails, fresh-water clams and mussels, Catfishes, Loaches and others being commonly used. Tadpoles of frogs are used with Goldfishes and in the house pond. The Fresh-water Flounder or Aeroplane Fish (*Achirus fasciatus*) and the docile South American Dwarf Catfishes (*Corydoras* and others) which are bottom feeders, at present head the list of favorite scavengers for the tropical toy fish aquarium. Two of these little fishes are sufficient for a 20 gallon tank.

151. Of what value are snails in the aquarium?

There are no more interesting animals than snails, both viviparous and oviparous. Their introduction is a matter of personal choice. To some minds no aquarium is complete without them, but some fishes annoy the snails, chew off their tentacles and kill them; and snails are not averse to eating eggs of fishes lodged among the pebbles or plants. It is quite worth while to maintain a snailery apart from the fish aquarium.

About one snail for each gallon of water usually will keep an aquarium free of algæ. The little *Physas* are considered best for this purpose. The algæ are removed by means of a tongue-shaped organ covered with rasping teeth and called a radula. (See also No. 22 on snails and infusoria.)

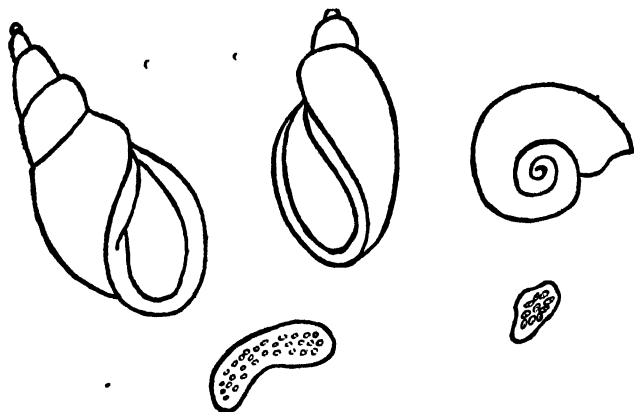
152. What food and care do snails require?

Snails usually are content with the fine stuff they find in the aquarium, also prepared fish foods. Soft-shelled snails and Ram-

horns are fond of lettuce. Red Ramshorns fed for many months on raw clam failed to reproduce, but when lettuce was provided they multiplied rapidly.

Snails do not eat such plants as *Vallisneria* and *Sagittaria*, but some species prey on soft leaved plants like *Cryptocoryne* and Spatterdock, and floating plants such as *Lemna*, *Salvinia* and *Azolla*.

Shell-making substances should be supplied, also not too acid water, otherwise the shell becomes perforated and death ensues. Powdered cuttle bone and plaster of Paris or calcium phosphate serve this purpose very well.



In the American Pond Snails the shell of *Limnaea* (left) opens to the right when held with the opening down; that of *Physa* (center) opens to the left. The shell at the right is that of the Brown Ramshorn (*Planorbis*). Below are their egg cases.

153. Which snails are commonly sold for the fresh-water aquarium?

The most colorful of the snails commonly sold for the home aquarium is the Red Ramshorn or Coral Snail (*Planorbis corneus*, var. *rubra*), brought to the United States years ago by Heede from Germany by way of Denmark and therefore called also the Copenhagen Snail. It is a red variety of the Brown Ramshorn. There is no handsomer sight than a company of large Copenhagen Snails crawling about the aquarium and they are active destroyers of algae, but care must be exercised in their use. The moving scarlet tentacles bear a fatal resemblance to *Tubifex*, and voracious fishes will chew them off and kill the snails.

Most of the Cichlids, the Swordtails, some of the Characins, Para-

dise Fishes, Rosy Barbs, Dwarf and Three-spot Gouramis, *Betta bellica*, *scalare*, Sunfishes and *Gambusia holbrooki* are inimical to snails.

Other snails of the pet shops are the Australian Red Snail (*Isadora proteus*), an excellent scavenger, orange red in color; Melanthero Snail (*Melanopsis grallisi*) or "horn of plenty"—so called because of the long spiral shell; the European and African Paper-shelled Snails (*Limnæa*) shaped somewhat like the Australian Red Snail, also the Columbian (*Marisa rotula*), one of the newer Rams-horns with a striped shell.

Two live-bearing snails, Japanese (*Viviparus malleatus*) and American, called the Potomac Green Snail (*V. [intertextus] contectoides*), are commonly available and they eat no vegetation except for the algae that forms on glass and plants. Two others which bear a superficial resemblance to these but have dissimilar habits are the Four-horned Snail (*Ampullaria gigas*) which favors a vegetable diet, and the Mystery Snail (*Pomacea bridgesi*) from Brazil* which lays its eggs above the water in cream colored, grapelike clusters of many hundreds, and which is not a plant eater.

In the live-bearing snails, the sexes are distinguished by the right tentacle, which is curled in the male, straight in the female. In the Mystery Snail the male has longer tentacles.

154. Which fresh-water snails can be collected in the United States?

The commonest snails found in the fresh waters of the United States are the small Brown Ramshorn (*P. corneus*) and the Pond Snails, *Physa* and *Limnæa*, always of value as scavengers, though because of their soft shells soon gobbled by fishes large enough to eat them. All these lack a door to their fragile houses. The Pond Snails are nearly related but distinguished by the direction in which the shells open—to the right in *Limnæa*, to the left in *Physa* when held with the opening down. Their maximum length is about one-half inch, though *Limnæa stagnalis*, formerly very abundant in the eastern states, reaches a length of two and one-half inches.

They ascend and descend in the water on their lines of slime much as a spider walks on its webline. The eggs of pond snails show a faint tinge of yellow (yolk) but otherwise are translucent.

* We are indebted to Mr. William J. Clench, Curator of Mollusks at the Harvard Museum of Comparative Zoology, Cambridge, Massachusetts, for the identification, which renders the snail no longer a mystery, though the common name is convenient and will stand.

and pearly as soap bubbles, and are laid in crescent-shaped masses of gelatin.

Another American species is the Potomac Green Snail which produces living young with shells too tough for infant fishes, though it is not as hardy in captivity as the live-bearing Japanese Snail. This species has four brown bands on the body whorl.

One snail, *Pomacea paludosa*, related to the Mystery Snail, is abundant in southern Florida, and doubtless many more North American species are suitable for the home aquarium.

155. How do snails reproduce?

Most snails are hermaphrodites, i. e., both sexes are present in each individual, cross fertilization takes place and eggs are laid. The Japanese and Potomac viviparous snails are exceptions to the rule, each being separately sexed and bringing forth its young alive. These snails actually are ovoviviparous, i. e., eggs are laid but the mother retains the young in her mantle until their shells have hardened sufficiently to protect them from smaller aquarium fishes. The Japanese Snail (*Viviparus malleatus*) attains a length of two inches and a circumference of four and one-quarter inches. Once fertilized, the female is fertile for life. The American viviparous snail, called the Potomac Green Snail, is similar in breeding habits but smaller, less active, and shorter lived.

These snails should not be discarded when they close the door of their house (the operculum), as they rest occasionally for a week or two; but if the operculum lies open, failing to contract when touched, they are dead. The female viviparous snail that dies should not be thrown out until the body is examined for young. There may be a dozen or more well advanced embryos in the mantle that can be saved by pressing them out into the water. Some raised in an aquarium bred when three years old. They do better in cool water and need watching if the temperature rises above 70°.

156. Will the fresh-water mussel clear up cloudy water?

Yes, if the tank is not too badly polluted by dead specimens, but large mussels are not hardy in captivity. Small mussels have lived for nearly two years.

157. Are Weatherfishes desirable scavengers?

They and all other Loaches roil the water to such an extent that many aquarists consider it better to use something else as scavengers and keep these fishes in a tank by themselves where they can enjoy life after their own fashion.

ABOUT YOUR AQUARIUM

PLANTS

158. Are plants necessary in an aquarium?

Fishes can live without plants. (See Nos. 26, 114.)

159. Can one grow aquatic plants in the aquarium without fishes?

Plants seem to do better when fishes are present.

160. What function do aquatic plants perform in the tank?

Aquatic plants absorb the gases that are harmful to fishes and liberate oxygen which is necessary for them. They absorb some of the refuse from the bottom of the tank and furnish a safe retreat for the young. Also, many fishes spawn upon the fine or broad leaves. Fishes, especially Goldfishes, hold their color better with plants in the tank.

Plants do not give off as much oxygen during the winter months as during the summer, and in winter may be helped by supplying them with electric light for two or three hours a day. This applies also to overcast weather generally.

Plants, through the agency of light—particularly red, orange and yellow light rays—manufacture carbohydrates from carbon dioxide and water; which is to say that under bright light, natural or artificial, they absorb carbon dioxide and give off oxygen. During plant respiration, oxygen is absorbed and carbon dioxide given off, a process which is masked in bright light by the opposite process of assimilation. On overcast days, therefore, the plants are unable properly to perform their oxygen-producing service to the fishes. The old method was to lift a dipper of water from the aquarium and let it drop back, slowly accumulating oxygen as it fell. (See also No. 114.) The modern method is to supply electric lighting as a direct aid to the plants.

161. Do aquatic plants grow better when planted in sand or gravel?

Plants generally grow better when planted in coarse sand mixed with small pebbles.

162. Is it safe to use soil to grow plants?

This method is used, but is dangerous. Even when the soil is covered with sand, the water becomes foul more readily than with plain sand. If fertilizing chemicals are present, they may seep out

1001 QUESTIONS ANSWERED

of the soil and modify the pH of the aquarium. Also, soil commonly is filled with gases.

Most plants do better, however, when rooted in soil. *Cryptocorynes* are good examples. Mr. Lanier placed one of these plants in a glass pot two and one-half inches deep and five inches in diameter, containing soil, and covered this with fine gravel. It has grown and spread until it covers an area about 18 inches in diameter in a 65 gallon tank. This *Cryptocoryne* (*C. griffithii*), which originally had six leaves, has been in the tank for over four years and many shoots have been cut from it for planting in other tanks.

163. Why do plants collected in streams turn brown and soon fall to pieces when placed in a balanced aquarium?

Usually the temperature where the plants are found is much lower and as they cannot withstand the change to warmer water, they fall to pieces.

Always remove straggly, shabby plants when they begin to turn brown—the sooner the better.

164. Which plants are best for the home aquarium?

More than 30 kinds are available, both rooted and floating, and may be selected according to the size of the aquarium, the light afforded, the type of plants necessary for catching the spawn of egg layers and for protecting the fry.

Many new plants have come into aquarium use during the past five years and like toy fishes, new species may be offered at any time.

The following are among those most commonly sold in pet shops, and for convenience are divided into Rooted Plants (with narrow, fuzzy, small or broad leaves, and slender, willowy plants), and Floating Plants:

ROOTED PLANTS:

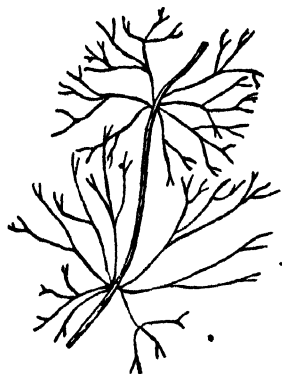
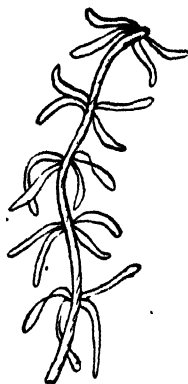
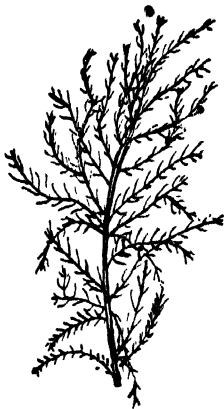
(NARROW LEAVED)

Arrowhead or *Sagittaria* of several species, including Giant *Sagittaria* (*S. sinensis*), the somewhat similar *S. natans* and the small *S. subulata*.

Tape Grass or Fresh-water Eel Grass, *Vallisneria spiralis*.
Hair Grass, *Eleocharis prolifera*. Especially desirable for aquaria of less than 10 gallons.

Quillwort, *Isoteles lacustris*, somewhat difficult to cultivate.

Water Stargrass, *Heteranthera dubia*, found from Ontario.



Upper left: Spiked Water Milfoil or Foxtail.

Upper right: *Cabomba* or Fanwort.

Center: Chilean Water Milfoil.

Lower left: *Anacharis* or *Elodea*.

Lower right: Hornwort or *Ceratophyllum*.

The "fuzzy" plants are easily distinguished if one examines the leaves. Milfoils are told from Hornwort by their pinnate, submerged leaves, finely divided into threadlike segments. Hornwort has widely branching and floating stems and the verticillate leaves appear in a thick cluster on the young growth and branches. *Cabomba* has fan-shaped leaves. In *Anacharis* four leaves occur together at about every half inch along the stem.

1001 QUESTIONS ANSWERED

to Oregon and south to Florida and Mexico. Thrives in very shallow water and has grasslike leaves and yellow flowers.

Umbrella Grass, *Cyperus alternifolius*. Grows above the water.

("FUZZY" LEAVED)

Elodea or *Anacharis* (so called from its older generic name), also known as Canadian Water-weed (*Elodea canadensis*). Fanwort, *Cabomba caroliniana*, called also *Cabomba* and Aquarium Moss.

Red *Cabomba*, *C. caroliniana*, var. *roseaefolia*, introduced into aquaria in 1934.

Water Milfoil, *Myriophyllum*, of several species. Parrot's Feather, the Chilean species, *M. proserpinacoides*, grows above the water and has been introduced into various states. Spiked Water Milfoil or Foxtail (*M. spicatum*) is common from Newfoundland to Florida and west to California.

Hornwort, *Ceratophyllum demersum*, anchors loosely in sand.

Najas flexilis, is a slender plant, fair oxygenator, and ornamental. Common everywhere in the ponds and streams of North America.

(SMALL LEAVED)

Ludwigia mulertii, called *Ludwigia*, is the cultivated form of wild Swamp Loosestrife. *L. rosæi* is still more colorful.

Moneywort, *Lysimachia nummularia*. Called also Creeping Jenny.

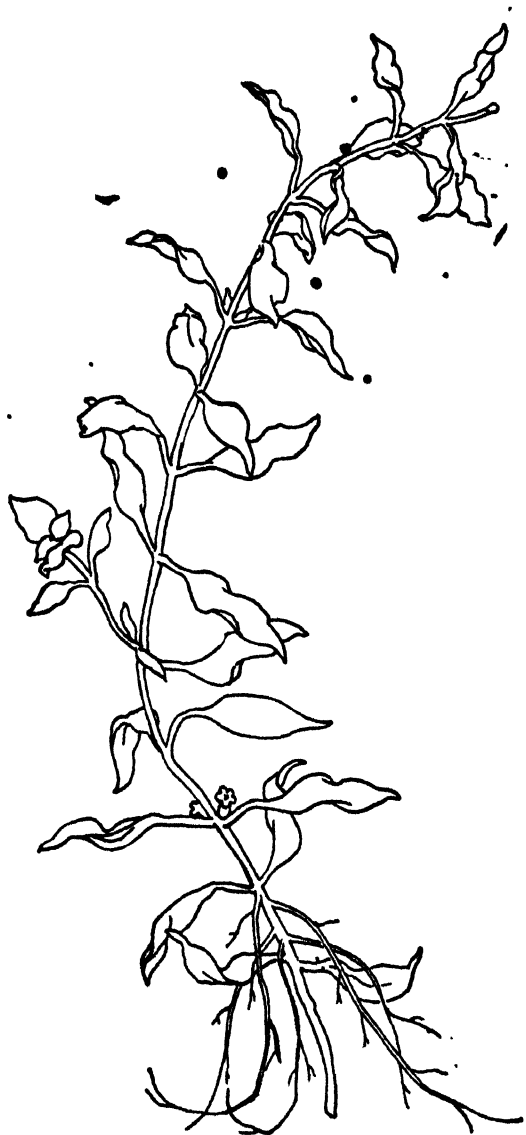
(BROAD LEAVED)

Cryptocorynes of four species: the Wide Leaf, *C. griffithii*, the Narrow Leaf, *C. beckettii*, also *C. cordata* and *C. willisii*. The *Cryptocorynes* are natives of the Orient and comprise in all 26 species.

Saururus lucidus, with heart-shaped leaves growing above the surface of the water like Umbrella Grass and Parrot's Feather.

Water Poppy (*Hydrocleys*). Has yellow flowers. There are several species.

Southern Spatterdock, *Nuphar sagittifolium*. Grown from roots and not successfully transplanted.



Drawn by Cecil Tose

Type of small leaved plant—Mulleit's *Ludwigia*. Though not one of the hardiest, it has been a favorite with aquarists for many years.



Drawn by Cyril J. MacMeekin

Types of Broad Leaved Plants

At the left, Southern Spatterdock, used principally in tanks of larger size. At the right, Madagascar Lace Plant, which is very decorative for the small pool.

Sagittaria guayanensis, introduced into aquaria in 1934.

Heteranthera zosteræfolia, indigenous to Central America.

Pondweed or *Potamogeton* of two species: the large *P. densus*, and the curly leaved, *P. crispus*. (There are at least 60 species.)

(SLENDER, WILLOWY)

Willow Moss of two species, *Fontinalis gracilis* and *F. anti-pyretica*.

Stonewort, *Nitella gracilis*.

FLOATING PLANTS:

• Bladderwort, *Utricularia*, of various species; but *U. minor* is the only safe species in the tank with fry.

Water Hyacinth, *Eichhornia crassipes*.

Water Fern, *Ceratopteris thalictroides*.

Water Lettuce, *Pistia stratiotes*.

Duckweed, *Lemna minor*, loved by fishes.

Salvinia natans, one of 13 species of *Salvinia*, also loved by the finny tribe.

Floating Moss, *Azolla caroliniana*, native in the south; re-



• Photograph by Robert J. Lauter

• Types of Slender, Willowy Plants

At the left, Willow Moss. At the right, Stonewort.

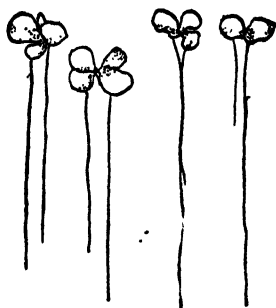
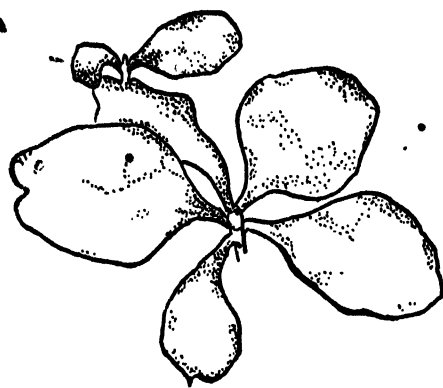


Drawn by Cyril J. MacMekin

in the sun, green in the shade. This is one of five species of *Azolla*, and is in the same order with *Salvinia*.

Crystalwort, *Riccia fluitans*.

Frogbit, *Hydrocharis morsus-ranæ*, introduced from Europe.



Drawn by Cecil Toss

Floating Plants

Above: Water Fern, showing method of reproduction by new leaves which sprout from the ends of parent leaves and break away.

Below: Duckweed, a favorite food of small turtles. Little fishes love to browse among the roots, which are populated with minute crustaceans and other natural foods.

165. Which plants are recommended for catching the spawn of egg layers?

The small Bladderwort (*Utricularia minor*), Crystalwort, Stonewort, Water Milfoil and *Cabomba*.

166. What is the difference between the Hornwort (*Ceratophyllum*) and the Milfoils (*Myriophyllum*)?

The Hornwort has heavier, needlelike leaves which are much firmer. The floating stems are widely branching and the leaves, called "verticillate," appear in a thick cluster on the young growth and branches. In the Milfoils, the pinnate, submerged leaves are divided into threadlike segments.

167. Which are the hardiest rooted plants?

All are hardy, except the so-called "fuzzy" plants, Fanwort (*Cabomba*), Water Milfoil (*Myriophyllum*), *Anacharis*, and Hornwort, though these are greatly enjoyed by fishes which not only eat them, but tear them to pieces. They have a tendency to rot at the roots. The most desirable of the four is *Anacharis*. If not rooted, the stems soon grow very long, and if allowed to float it is a simple matter to nip off the decaying root ends.

168. Is it possible to observe circulation in plants?

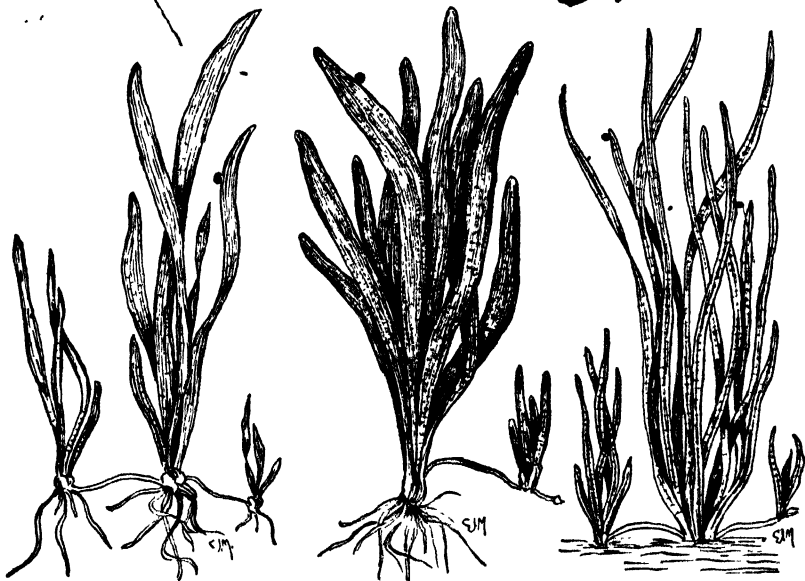
Those who own a microscope may learn something about the circulation of protoplasm in plants by observing the phenomenon in bits of *Anacharis* or *Vallisneria*.

169. Which plants are the best oxygenators?

The best oxygenators are the straight leaved plants - *Sagittaria* and *Vallisneria*. These plants reproduce by rhizomes sent out from the roots and forming new plants. An old standby for aquariums of more than 12 gallons' capacity is the broad leaved *Sagittaria* or Arrowhead (*S. sinensis*). The leaves are great favorites with *scalares* in breeding time, forming a favorite depository for the eggs. Other species of *Sagittaria* such as *S. natans* and *S. subulata* are more suitable for smaller aquaria. *Sagittaria natans* blooms in the aquarium after the formation of arrow-shaped leaves which reach the surface of the water, the flowers being small and white, with yellow centers. Somewhat like *Sagittaria* and very popular for the tropical fish tank is the Tape Grass, *Vallisneria*. *Anacharis* and *Cryptocoryne* also are good oxygenators.

170. How can one distinguish between *Vallisneria* and *Sagittaria*?

This is a difficult matter, except for the sharp-eyed. The leaves of *Vallisneria* are a brighter green and less opaque than *Sagittaria*, sometimes having a yellowish tinge. *Vallisneria* also has a lesser



Drawn by Cyril J. MacMeekin

Arrowhead and Tape Grass Are Not Easily Distinguished

At the left: common Arrowhead (*Sagittaria subulata*). Center, Giant *Sagittaria* (*S. sinensis*). Right: Tape Grass (*Vallisneria spiralis*).

Their mode of reproduction by rhizomes which send roots below and leaves above, is similar; but the leaves of *Vallisneria* are brighter and less opaque, and it grows straighter than *Sagittaria*, which spreads out over the aquarium.

tendency to spread out over the aquarium, i. e., it stands up straighter as a rule, and does best in a deep tank.

171. Which are the daintiest aquatic plants for the home aquarium?

Without doubt the Willow Moss (*Fontinalis*) and Stonewort (*Nitella*), with the Bladderworts (*Utricularia*), running a close third. Hairgrass and Quillwort are dainty also.

172. Which are the best surface floating plants?

The best of floating plants is the Crystalwort (*Riccia*) which forms a veritable hanging jungle, sometimes two inches deep, and serves as an ideal hiding place for fry seeking safety from their parents. Next to this is *Salvinia*, larger leaved, longer lived, and more attractive than Duckweed. Next, if one can get them, are the southern Water Ferns which spread over the surface of the aquarium by means of new plants sprouting from the ends of the parent leaves and then breaking away. Water Ferns are five or six inches in diameter and better suited to aquaria of a capacity of 15 gallons or more, and one plant is entirely ample for a tank of any size. The Water Lettuce is an exceedingly lovely plant with leaves like velvet and a diameter of about three and one-half to four inches, but it is not durable. The Water Hyacinth, with its pretty blossoms, is better suited to the garden pool, like water lilies and lotuses, and for catching Goldfish eggs the roots have long been in favor.

173. Which are called the most beautiful of aquarium plants?

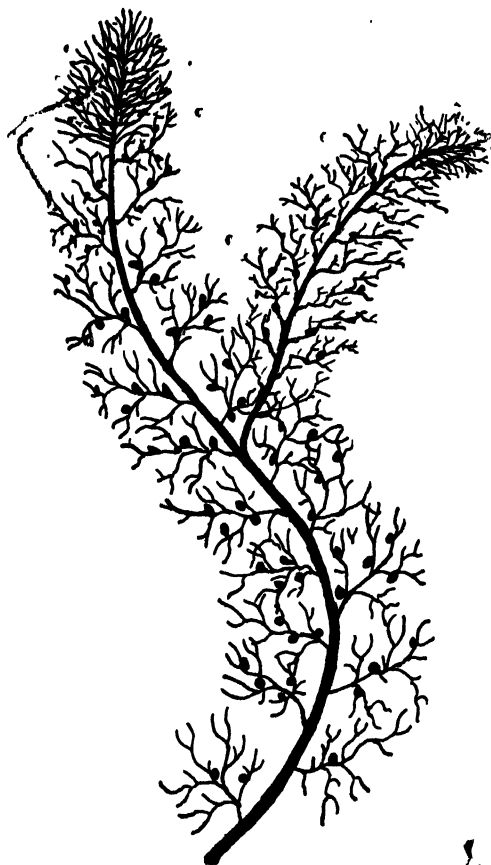
Ludwigia because of the rich garnet coloring of the under surface of the leaves and the new red *Cabomba*. *Ludwigia* is not as hardy as some others. The new broad leaved *Sagittaria guayanensis* is hardier and pretty.

174. Do Bladderworts injure fry?

This depends on the size of the bladders. Large bladders capture minute fry, but plants with small bladders are safe in the aquarium. Their natural food consists of protozoans, rotifers, nematodes, water fleas, snails, and insect larvæ. Bladderworts will float beneath the surface like *Anacharis* and Hornwort, and when not flowering live entirely submerged. The small Bladderwort, *Utricularia minor*, is safe with fish fry, but *U. vulgaris* and others with large bladders capture infant fishes, becoming piscivorous plants when opportunity offers.

Bladderworts are called carnivorous plants, because they feed on animal life. This has been proved by experiments which show that if the plants are prevented from capturing animals they remain dwarfed.

According to Agnes R. Arber an "edible mucilage is secreted by the hairs which grow on the bladders and especially on the valve at the aperture." This attracts the prey which enter the bladders and cannot escape. Twelve *Daphnia* have been observed moving restlessly about in a single bladder. The prey suffocate or starve and



Drawn by Robert J. Lanier

The Lesser Bladderwort

Bladderworts may be allowed to float in the aquarium, but they are carnivorous plants and if one is rearing fishes, the Lesser Bladderwort should be chosen. In this species (*Utricularia minor*) the bladders are too small to capture the fry. the decaying products are absorbed into the cells of the bladder and thence into the plant tissues. (Bibliography No. 119.)

175. Does Eel Grass grow in fresh water?

No. Eel Grass is the name of a marine plant, *Zostera marina*, which is a favorite haunt of little Eels or elvers, as well as an im-

important food for aquatic birds, which probably enjoy the Eels along with the Eel Grass. The Eel Grass, which was disappearing from both coasts of the Atlantic a few years ago, is said to be reestablishing itself. *Vallisneria*, because of its resemblance to the long, grass-like blades of Eel Grass, sometimes is called Eel Grass, but this is not correct, though it may properly be called Fresh-water Eel Grass.

Fresh-water plants sometimes are called seaweeds, but like "Eel Grass," this is a wrong designation. Seaweeds live only in salt water.

ENEMIES OF FISHES

176. Which are the principal enemies of small aquarium fishes?

Fishes are their own worst enemies, besides which are turtles, frogs and salamanders. (These always should be kept in separate quarters. See The Terrarium.) Other foes are leeches, the larvæ of certain insects (such as Dragon Flies), water beetles such as the Water Tiger, and Great Water Bug and other bugs, some of which are armed with spears for impaling little fishes. The Water Boatman (*Corixa*), Water Scorpions (*Ranatra* and *Nepa*), and Back Swimmer (*Notonecta*) all are predatory bugs, and when not swallowed by larger fishes, eat fish eggs and fry. Hydra prey on little fishes, as do spiders, also *Utricularia*—the Bladderworts, which live principally on minute water animals including very small fry of fishes. Besides these visible enemies are pathogenic protozoa, bacteria and worms as disease-producing enemies. *Argulus* and *Lernæa*, crustacean parasites, prey on Goldfishes and other larger fishes, and are called "fish lice," though not lice.

Water Tigers, Dragon Flies, Hydra and other fish enemies sometimes get into the aquarium with new plants introduced without sterilizing, and sometimes with Daphnia. To separate beetles, bugs and insects from Daphnia, use a screen large enough to permit the Daphnia to pass but too small for the others. Place it just beneath the surface of the water and pour the Daphnia into it. The others will remain on the screen while the Daphnia sift through.

177. What are Hydra?

Hydra are threadlike animals, green or brown, about one-quarter of an inch long, commonly found on the under side of floating leaves, the leaves of submerged plants, or on stones in shallow water. In the aquarium they attach themselves to glass and plants.

They are fresh-water polypes, allied in structure to coral polypes and sea anemones, and are among the most beautiful and curious

of small aquatic animals. They are of two varieties, Old and New World.

From five to eight graceful but deadly tentacles surround the mouth. These tentacles are hollow and connected with the body cavity. Many tiny "trigger-hairs" may be observed under the microscope. These, when touched, cause the discharge of poisonous threads. Daphnia, fish fry and other minute organisms coming in contact with the tentacles thus are paralyzed, seized by the tentacles, and conveyed to the mouth at their base. Microscopic plants also are eaten.

When alarmed, Hydra retract and the bunched-up bodies with outspread tentacles look like minute green strawberries.

Each animal contains both sexes. Reproduction is either by eggs or, more often, by the growth of little buds along the body, exactly like the parent, which break away, never forming colonies like corals.

A sticky secretion glues them to their anchorage, but they are able to detach themselves and move about like looping caterpillars; also, they can walk on their tentacles.

The name Hydra is derived from the mythical, hydra-headed monster of old which could reproduce its heads as fast as they were severed, many experiments showing that Hydra is almost as difficult to kill.

Any fish small enough may fall a victim to the Hydra, including trout fry.

178. By what method can an aquarium be rid of Hydra?

There are several methods:

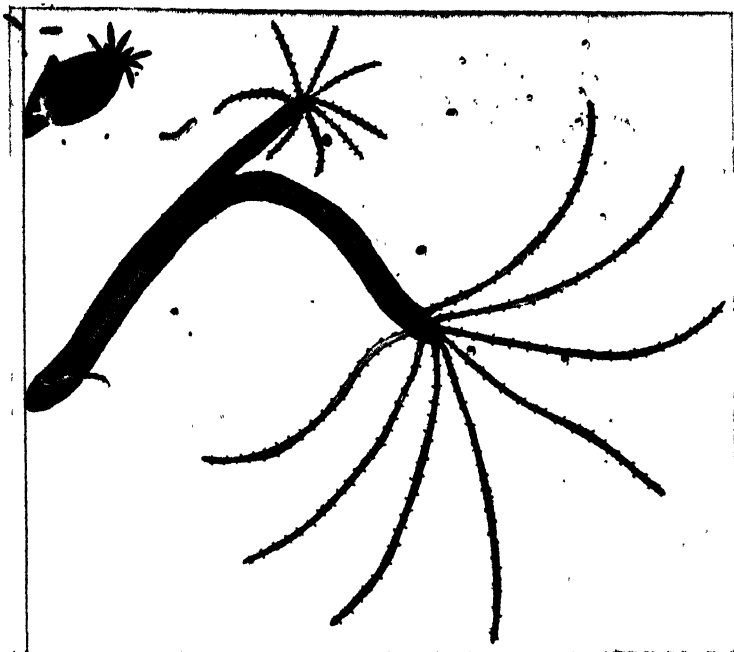
By removing plants, fishes and snails and raising the temperature of the water to about 100° for at least an hour.

By removing the fishes and snails and adding 22 drops of ammonia to each gallon of water for a 35 minute bath. Rinse well afterward, especially the plants; clean the tank and fill with fresh aged water.

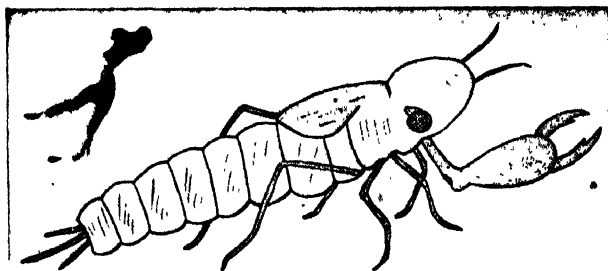
By introducing fishes which eat Hydra. The Australian fish, *Craterocephalus nouhuysi*, has an insatiable appetite for Hydra. *Mollienisia* and the Three-spot Gourami (*Trichogaster trichopterus*) have been observed to eat them. The common newt also devours Hydra.

179. How can Dragon Fly larvæ be distinguished from other aquatic insects?

Dragon Fly larvæ have stout bodies and large heads. A protrusible jaw, called a "mask" and shaped like a pair of ice tongs,



•The Hydra, fresh-water cousin of the corals, eats water fleas and little fishes, and is eaten by some larger fishes. Its buds, unlike coral buds, break away and live independently. When alarmed the Hydra retracts, looking like a minute green strawberry. (Upper left.) Greatly enlarged.



Dragon Fly larva, showing protrusible jaw called a "mask" and shaped like a pair of ice tongs, for grasping tadpoles, little fishes and other prey.

can be darted out suddenly to seize an unsuspecting passerby in the shape of a fish, tadpole, or brother Dragon Fly. A Dragon Fly larva can make away with several dozen little fishes in a day.

May Fly larvæ are distinguished by their three feathery tails and small defenseless heads. Some species have biting organs and are predacious, but the majority eat only mud in the larval stage and nothing in the winged stage.

The natural food of Dragon Fly larvæ consists of tadpoles, mosquito larvæ, and other small, soft animals. Though they eat many little fishes, larger fishes, especially Trout, eat them. They are sluggish but voracious, and genuine head hunters, for if a number of Dragon Flies are placed together in a jar, most of them will soon be found minus their heads which are not only severed but devoured by their fellows.

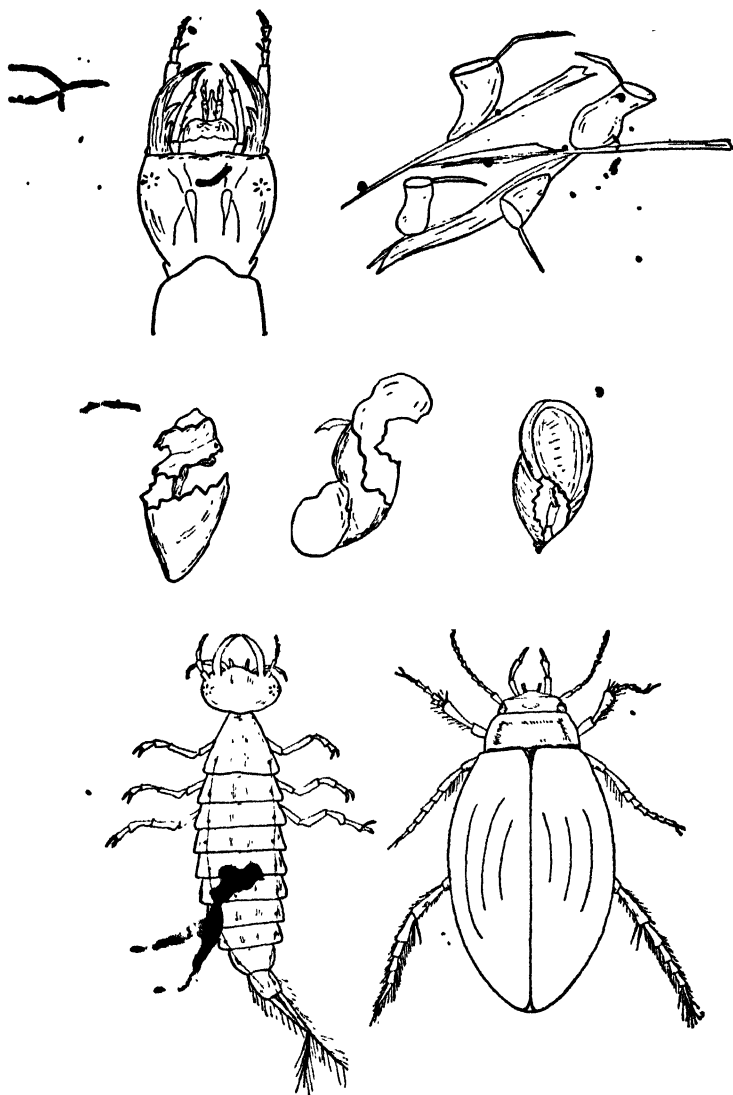
They may live for a year in the larval state. On quitting the water they ascend a plant stem and cast their skins, emerging with wings which speed them at the rate of 60 miles an hour after their insect prey. All their lives they are relentless enemies of mosquitoes and flies. On the wing a Dragon Fly can take 100 mosquitoes in its mouth at one time and will capture 40 house flies in two hours. They mate at the surface of the water, into which the eggs are dropped, and the wedding of the Dragon Flies is a beautiful and imposing sight.

180. How long do May Fly larvæ remain in the water?

Their larval life covers from one to three years, during which they molt 20 times. They form an important fish food and among small aquarium species the Darters prey most persistently upon them.

181. How does the Great Water Bug capture a fish?

The prey is grasped with the strong clasping legs and its deadly beak plunged into the flesh. A copious supply of saliva poured into the wound is believed to paralyze the victim. The bug then proceeds leisurely to suck the blood. Frogs, Mud Minnows and other soft little animals form the food of the Great Water Bug, called Electric Light Bug because it is attracted to arc lights in its summer night flights. The habits of the Water Scavenger Beetle (*Hydrophilus*) are somewhat similar. The large black beetle hibernates in earth during winter. In the spring the female weaves under water a cocoon of coarse yellow silk shaped like a long-bowled pipe, stem and all, in which the eggs are laid to the number of 50, 100 or



Both Enemies and Prey of Fishes

Top: head of the Water Scavenger Beetle (*Hydrophilus*), with egg cases. Center: examples of carpentry on snail shells. Below: Water Tiger and Predacious Diving Beetle, which are the larva and adult of the same animal. These beetles eat little fishes and are eaten by larger fishes.

more. These artistic little nests sometimes are attached to water plants and sometimes left free, floating stem up.

182. How can one tell the larva of the Water Scavenger from the larva of the Water Tiger?

It is similar in shape of body, but has shorter legs and smaller head and mandibles than the Water Tiger larva. It preys on snails, tadpoles, mosquito larvæ, fishes, and other beetles.

A mosquito wriggler exhibit at the New York Aquarium was devastated of nearly all its specimens—about 25,000 larvæ and pupæ—by the larva of an Electric Light Bug before its presence was detected.

Considerable ingenuity is shown by these water insects and their larvæ. Pond Snails can shrink so far inside their shells that the bright but clumsy larva cannot reach them from the opening. It therefore saws the shell with its sharp mandibles, cutting into it until it can touch the animal and suck out its tender body. It does not hesitate to attack fishes and other animals larger than itself.

183. How does the larva of the Diving Beetle or Water Tiger (*Dytiscus*) capture a fish?

The larva, which is dressed in soft cream and brown, is not overquick in pursuing and seizing its prey, and a nimble animal like the Fresh-water Shrimp can elude it. Sickle-shaped mandibles pierce and hold the victim and contain canals through which the softer portions are sucked out. Snails, worms, insects, fishes, mosquito larvæ all fall prey, and Water Tigers will eat the heads of beetles and bugs of smaller size. One observed by Miss Mellen ate not only little fishes but in 24 hours captured and devoured 39 small tadpoles. In the pupal stage it buries itself in the earth, emerging as a shiny black beetle ready for another long and rapacious career.

184. What is the difference between a bug and a beetle?

Bugs either have no wings or fold their wings crosswise instead of straight up and down like beetles. The head usually is separate from the thorax. Like beetles, however, their mouth parts are adapted to piercing and sucking, and all are carnivorous, eating other bugs and insects, even their own offspring, water fleas, and the like; and some prey on fishes and fish eggs.

185. How do Water Scorpions capture a fish?

Their fore legs are fitted to close upon the prey like a jack-knife. They have long scorpionlike but harmless tails and live near the bottom, *Ranatra* attaining a length of two inches and resembling a stick more than a bug. The head is nearly one-third the length of the entire body, which is encased in a protecting coat of mail. Telescopic breathing tubes enable it to reach to the surface for air while hunting below for other insects, fish spawn, little fishes and mollusks.

186. How can one tell a Back Swimmer from a Water Boatman?

They are much alike and both frequent the surface of the water, but the Back Swimmer is a handsome white bug with scarlet eyes and swims on its back, making long, vigorous and telling strokes with oarlike feet, while the Water Boatman is dark and broader, swims in the same way but with back up like a beetle, and is not as buoyant as the Back Swimmer, spending more time at the bottom. It has strong, serviceable wings. There are numerous species of Water Boatmen, some of which attach their eggs to aquatic plants. (Another argument for sterilizing plants before introducing them into the aquarium.)

FOODS OF AQUARIUM FISHES

187. What is a good general food for aquarium fishes?

Many toy tropicals are largely carnivorous, like ocean fishes; others, like Goldfish, prefer vegetable food. The majority will accept raw meat, shellfish and cooked cereal.

The following fish food is used by Mr. Lanier at the Steinhart Aquarium, where toy fishes and large carnivorous fishes thrive alike on this diet, which includes lettuce and oats:

5 pounds of fish (flounders or herring)

3 pounds of beef heart

1 large head of lettuce

2 cups of clams or mussels

2 cups of rolled oats, and enough dried shrimp to make the mixture like dough when ground fine.

If dried slowly in an oven, it will keep for a considerable time in Mason jars.

188. What is the best food for herbivorous fishes?

Few, if any, fresh-water toys are strict vegetarians, even the Mollies, which require much algæ, taking animal substances also; but if the salt-water tropical aquarium becomes a reality in the American home, this question may be of importance. Four Eyes, Butterflies, Blue Tangs, Surgeons, Parrotfishes and others are largely herbivorous, browsing principally on marine algæ with a flavoring of coral polypes, sea worms, and other soft invertebrates. At the Fairmount Park Aquarium in Philadelphia, Dr. Robert O. Van Deusen feeds such specimens as these with the following mixture:

- 1 pound oatmeal,
- 1 pound each of string beans, carrots, potatoes and lettuce,
- All cooked well.

189. What foods are best for carnivorous fishes?

Carnivorous fishes, even those which are strictly fish-eaters, can be induced as a rule to take strips of beef or beef heart, also earthworms dangled before them. Sometimes they take fish (fresh or salt) in strips, also shellfish (mussels, clams, crayfishes, snails and the like). Fish roe is an excellent food for omnivorous species, and some carnivorous fishes will browse on it when the roe is split and laid on the bottom of the tank. This food is rich in Vitamin A.

190. Of what do most prepared fish foods consist, i. e., the dried foods sold in pet shops?

The basis of most of these foods is ground puppy biscuit and dried shrimp.

191. Which are the best live foods for small aquarium fishes?

For the smaller kinds, the best live foods are chopped raw earthworm (*Lumbricus*), or whole white earthworm (*Enchytraeus*), blood worms (larvæ of midges, *Chironomus*), the red brook worm, *Tubifex*, water fleas (*Daphnia* and the rest) and, when procurable, mosquito larvæ and pupæ.

For larger fishes, mealworms (*Tenebrio*) which may be fed whole or chopped, fresh-water *Gammarus*, the brine shrimp (*Artemia*), maggots, *Asellus* (water sow-bug), the fairy shrimp (*Branchipus*), and the glass worm (*Chaoborus*), the last two being excellent for winter food where collectable. Another maggotlike food which the present authors recommend is the wax-worm (*Galleria mellonella*). Wingless flies of the genus *Phoridae* can be reared for winter use. Their natural food consists of fleshy fungi, or dead and decaying animal and vegetable substances.

192. What is the best food for fry and fingerlings?

The fry of most fishes show strong cannibalistic tendencies, even Goldfish fry, and it is customary to sort them according to size. In a state of nature they live on plankton (microscopic plants and animals floating in the water), algæ, diatoms, desmids, rotifers, infusoria, minute larvæ of insects, and crustaceans.

Many fine specimens have been reared on powdered baby fish foods which consist largely of desiccated egg yolk finely ground, puppy biscuit and boiled shrimp, with a little lime such as powdered cuttle bone. Skim milk powder also is used and powdered Cod liver meal, but the latter is at present manufactured in such small quantities that the entire output is contracted for. Salmon meal (dried ground Salmon eggs) also is rich—and rare.

It is customary to rear infusoria for the fry. (See No. 220.)

For fingerlings, Cod liver oil cake meal may be used if soaked in hot water until soft. It is rich in vitamins.

193. How often and how much should fishes in the home aquarium be fed?

Adult fishes should be fed once a day and younger ones from three to six times a day. The younger they are, the more often they require food, and very young fry should be given very small amounts at each feeding.

The amount fed depends on the kind of fishes kept, the temperature and food. The best plan is to feed a little, and repeat as often as the fishes will take food. Should any go to the bottom, stop feeding. After a little experience in feeding, the required amount will be easily guessed for the different species.

Fresh-water fishes do not eat as much in cold water, taking very little food during the winter but eating readily when the water becomes warmer and the breeding season approaches.

194. How long can fishes live without food?

Most fishes can get along for a considerable time if there is plenty of plant life for them to nibble at. This is one reason why they make such desirable pets. One can go away and leave them for a month and find them well and happy on returning. If they are mainly carnivorous, however, the case is not so easy. Some tropicals require feeding at least once in 10 days, whereas omnivorous species have lived without being fed for from eight weeks to three months.

195. Can earthworms be kept over the winter?

They can be kept in earth covered with rotting leaves. Moistened slightly and keep cool. A wooden box 24 x 14 inches and about 12 inches deep, with a cover, is suitable. They may be fed twice a week with boiled white potatoes or other starchy food.

196. What are white earthworms (*enchytræids*), and how can they be bred?

They are real earthworms and over 50 kinds have been identified. The species commonly used for feeding fry of fishes is *Enchytræus albidus*, which reaches a maximum length of about 25 mm. and about 1 mm. in diameter. It ranges from New Jersey to Maine, coastwise, under decaying seaweed and stones, and is common also in Europe. Sometimes it is found around the roots of old trees. It lays its eggs in cocoons, a large number in each cocoon, and reproduces rapidly. Both sexes are present in each individual. This species is white because it has only white blood corpuscles and the body likewise is colorless.

The worms commonly are shipped by dealers, with a little earth, in small wooden containers.

They should be placed in a large wooden box about 10" x 8" x 8", using rich earth. Ordinary garden soil mixed with one part sand is very good. Cover the box to preserve the moisture, but leave an air space of an inch or so at the top. They should be fed once or twice a week with bread soaked in water, milk or diluted condensed milk; or with boiled cereal, such as oatmeal, boiled white potatoes, rice, or sour milk. Some breeders feed with cheese rind or crushed bone. Raw fish is much relished by the worms and they breed rapidly on this diet. They do better in a cool place, a cool cellar being an ideal breeding place for them, with a temperature of between 55° and 60°.

If the soil is too acid or too moist, it will retard reproduction. It should be turned occasionally to prevent it from becoming packed and wet. To keep the earth from souring, it is well to have a reserve box and change from one box to the other from time to time.

The red insects generally found with white worms will not harm the culture.

The worms congregate where food is present and if one has only a few fishes it is easy to remove a little earth with the worms and pick them out with a small forceps. If one has many fishes, a handful of earth containing the worms may be placed in water, where the worms soon become detached and group together. Or, if the earth is placed in a warm spot for a few moments, the worms will rise to

the surface. Sometimes they are easily captured if a glass cover is placed directly on the earth, as they have a tendency to collect upon it. If a piece of burlap is kept on top of the earth and moistened the day before the worms are needed, many will be found settled upon it.

197. Are enchytræids a desirable food for all toy fishes?

Doubts have been raised on this point. People have reported that Gourami develop dropsy and fishes in community tanks get sick when fed exclusively with white worms, but generally speaking *Enchytræus* appear to have outlived adverse criticism. In a state of nature the foods of fishes are varied and in the aquarium it is well to vary also. Two kinds of foods may be alternated for a week or so, then two other kinds.

198. What are blood worms?

In fresh water, blood worms are the red larvæ of a non-biting fly or midge (*Chironomus*). These often are found in the mud of ponds and lakes and in cistern water, also on dead leaves and on the under surfaces of water lily pads where they fall prey to surface feeding fishes. The blood worm models its home of particles of silt and leaves glued together by a viscid saliva. This flimsy shelter is attached to pebbles and leaves, but is deserted frequently when the blood worm sets out to look for food. It eats microscopic plants and animals and decaying vegetation. Brook Trout live almost exclusively on blood worms.

Marine blood worms are *Nereis* of several species found in sand flats at all seasons. They swim by night and during the day may be found under stones, shells, and in sand or mud between tide marks, where they commonly are sought by fishermen for bait.

Blood worms of fresh and salt water form one of the natural foods of wild fishes.

199. What is a *Tubifex* worm?

It is an aquatic ringed worm, ruby red in color, which builds itself a tube of slime and mud into which it can retreat. It can stretch at pleasure from a length of one-half inch to three inches. When seeking acquaintance with a new environment, it stretches out; when alarmed, it recoils. Its life is spent above its burrow continually waving its slender body in search of food while the tail is secured to the inside of the burrow for safety.

These worms live in vast numbers in the upper layers of mud in ponds, brooks, and ditches. When shaken out of their tubes and

placed in clear water, they are an odd study. They approach and coil about one another until hundreds are wound into a ball of writhing bodies. The mass will travel like one individual, in the direction of food, or away from strong light, some pulling, others apparently pushing. A ball of about 300 worms, measuring half an inch in diameter, was kept under observation by Miss Mellen, and when hungry, the mass traveled one and one-half inches in two minutes toward a crumb of bread.

Tubifex worms will survive in salt water for one and one-half hours.

200. What are water fleas?

They are not fleas but small crustaceans visible to the naked eye. Their habit of jerking is responsible for the name "flea." They consist of *Daphnia*, *Sida*, *Moina* and many others so closely related to *Daphnia* as to go by the same name, and various species of *Cyclops* and *Cypris*. *Daphnia*, which possess a small heart, are the largest and considered most desirable for fish food though in the wild state little fishes eat all kinds.

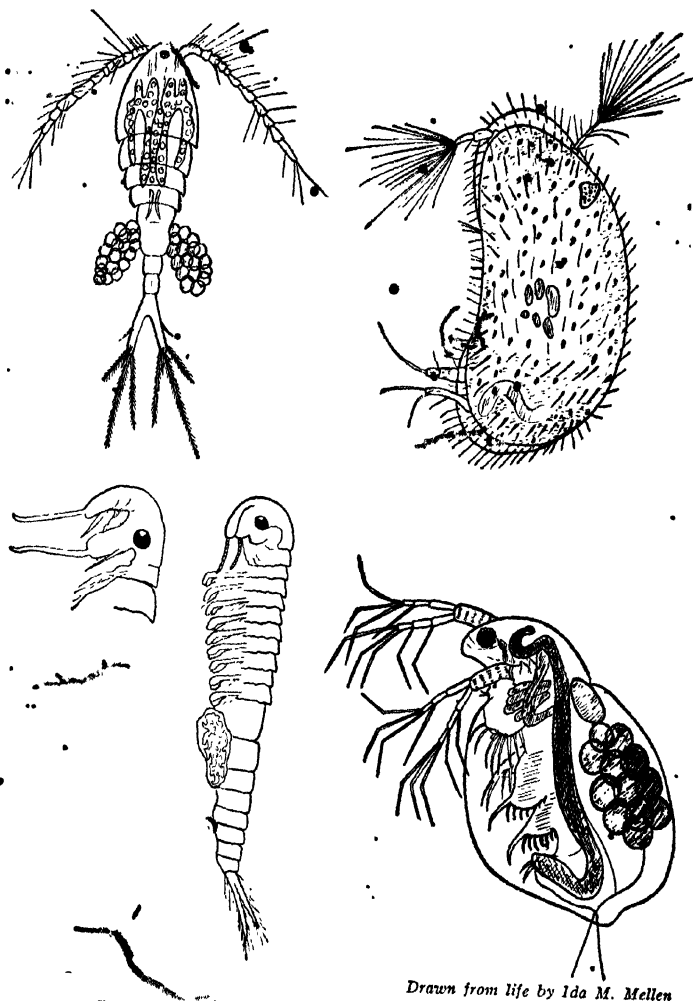
Cypris has a tough double shell, eats vegetable and animal substances, living or dead, and is believed to be inimical to snails. Sometimes it creeps and is preyed upon by various fishes which feed along the bottom and swallow mud. Its shell is golden brown with green spots and if the eye is quick enough to follow it, one may see it amusing itself by spinning in a circle with wonderful speed. It is a choice tidbit for Cichlids, such as *scalare*, and exists in immense numbers in every stagnant pool. Like *Cyclops*, the animal has no heart, but unlike *Daphnia* and *Cyclops*, it possesses two eyes or none.

Cyclops is a beautiful crustacean, the female of which carries her two large bags of eggs one on each side of the body. Like *Daphnia*, *Cyclops* has but one eye. In one species the eye is scarlet, the body burnt orange, and the egg sacs bottle green. A fish must move rapidly to catch a *Cyclops*, its movements are so truly fleetlike. It does not breed as rapidly as *Daphnia*, one female producing but four and on half billions of young a year. It swarms in stagnant pools also in brackish water.

All the water fleas swim by pushing out their delicate feet and antennæ.

201. Where can one find *Daphnia*?

Daphnia are found commonly in ponds, especially those that lack fish life and are slightly sluggish, also lakes, and often in com-



Drawn from life by Ida M. Mellen

Crustacea Live Foods for Small Fish Mouths

Top row: Cyclops, and the much smaller Cypris. Lower row: the Fairy Shrimp (*Branchipus*), showing head of male and female with brood pouch; also Daphnia with 12 summer eggs. (The oval body above the eggs is the heart.)

Cyclops, Cypris and Daphnia are called "water fleas," the first two being barely visible to the naked eye. The Fairy Shrimp swims on its back and is collected for winter food. It may reach a length of one inch or more.

pany with Cyclops and the much smaller Cypris. They are found in both acid and alkaline water, but more plentifully in alkaline or neutral water. Daphnia are variously colored. The best time to collect them is in summer in the early morning, when they rise to the surface in large numbers.

202. Are water fleas nourishing food for fishes?

Crustaceans of any kind are low in nutrition, but the shells furnish lime, so necessary for the health of fishes, and pursuing them provides good exercise. Because they help exhaust the oxygen, only one-fourth teaspoon of Daphnia should be introduced for each fish.

203. How can Daphnia be bred?

Some people have succeeded in breeding Daphnia in small aquaria. One experimenter used an eight gallon jar and fed with ground cuttle bone, ground raw oatmeal and infusoria from decaying lettuce. He succeeded in breeding enough to feed his small tropical collection. But generally the breeding is carried on in outdoor ponds or artificial pools. Those raised in artificial pools are taken indoors in winter. When a Daphnia pond is started, it is spread first with earth and horse manure. Infusoria, always present in decaying vegetation, serve as food, rotting lettuce being much relied upon for this purpose. Many heads of lettuce are kept standing in tubs of water and the water dished out for transference to the Daphnia pool when it is ripe. The Japanese method is to feed the Daphnia with boiled oatmeal water.

Miss Mellen raised many thousands in a 100 gallon tank in which plants were growing in earth covered with sheep manure. The natural food appears to consist of floating and free swimming algæ, for if placed in a tank in which the water is green because of the presence of algæ, they soon clear it. They eat also infusoria, desmids and diatoms.

One experimenter tried feeding with yeast, but this proved fatal to the Daphnia unless a stream of compressed air was kept bubbling through the culture at all times. Preparations now are on the market for the rearing of Daphnia, the Daphnia and their food being shipped together.

Summer. Daphnia are females and lay numerous asexual (i. e., unfertilized) eggs, usually two to 15. The young pass through a metamorphosis within the egg and hatch in the form of the adult, and almost immediately after birth the females begin to produce asexual eggs. Daphnia breed every few days in summer, one female being

credited with producing 13 billion descendants in 60 days. Males are hatched only once or twice a year. After they appear in the autumn the females lay fertilized eggs, usually only two, which are surrounded by a very tough shell. The brood pouch becomes detached from the remainder of the shell and closes about these eggs to protect them. They remain dormant until spring and are called "winter eggs."

204. What is a crustacean?

The crustaceans occupy one class in the division of jointed-footed animals—Arthropods. They are grouped in two sub-classes, the large and the small. The large (Malacostraca) include lobsters, crabs, prawns, shrimps, crayfishes, *Asellus* and others; and the small (Entomostraca) embrace *Branchipus*, *Artemia*, the "water fleas," *Argulus*, and other simple forms.

205. How can one feed with mosquito larvæ and pupæ?

By collecting the egg rafts which will be found floating on ponds and in brackish marshes everywhere in spring and summer and which may contain from 200 to 400 eggs. Mosquitoes breed in small places such as rain barrels, flower vases, and rain water standing in hollows of trees and pans. If one is fortunate enough to find a newly formed raft, it can be transferred directly to the aquarium and the fishes will do the rest, the wrigglers emerging within 48 hours. They eat infusoria, desmids and diatoms.

206. What are larvæ and pupæ?

Insects pass through three stages: the larva which eats, the pupa which usually does not eat and often sleeps, and the imago which flies and breeds. (The butterfly is an imago, the caterpillar which hatches from her egg is a larva, and the chrysalis into which the caterpillar turns is a pupa.) Mosquitoes may pass from egg to adult in two weeks or less during hot weather, or they may remain larvæ for months and molt three or four times before turning into pupæ. Usually it takes about one week for the mosquito larva to turn into a pupa, and in this case the pupa, though it does not eat, remains active, furnishing excellent food for fishes in both larval and pupal states.

207. How can mealworms be bred?

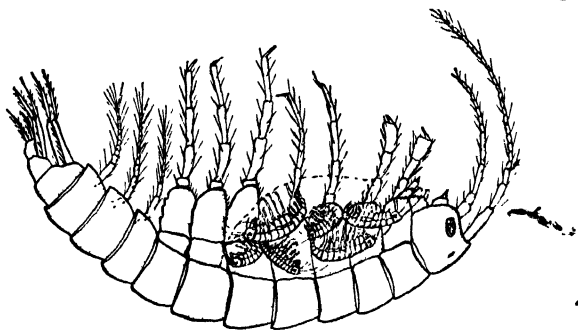
Mealworms, commonly sold in pet shops and granaries, are found in old wood earth, also in stale grain and corn meal.

The mealworm is not a worm but the larva of a black beetle. The beetle lays eggs which hatch into mealworms, and after a few months of feeding, the yellow worms turn into white pupæ which sleep for a short time and then metamorphose into black beetles, thus completing their life cycle.

Mealworms may be bred in a barrel, box, or old aquarium by placing them in malt or corn meal. They feed also on raw carrots, potatoes and other vegetables. A cloth should be laid on top for moisture and the receptacle kept covered, preferably with fine wire, coarse cloth or mosquito netting, to prevent the adults from flying away.

208. What are *Gammarus* and how can they be bred?

Gammarus are crustaceans with the body compressed (flattened from side to side) and are found in both salt and fresh water. Their maximum length is 10 mm., the new-born young measuring 1 mm.



Drawn from life by Ida M. Mellen

The Fresh-water *Gammarus*

This crustacean and its cousin, the salt-water *Gammarus*, are favorite foods of nearly all small fishes. They swim back down. A female is shown, with young in her brood pouch. The adult length is 10 mm., the length of new-born young, 1 mm.

There are several species, *G. fasciatus* being the common North American "fresh-water shrimp" used as fish food. They range in color from pale yellow to rich green with intermediate yellow, orange, brown, gray and green tints and shades. Their popularity as fish food is demonstrated by the rate at which a Mud Minnow can dispatch them—40 in an hour. They abound in roots of *Salvinia*, Duckweed, and other floating plants.

Their breeding habits are interesting, the eggs being carried in

a brood pouch situated beneath the mother's thorax, and the young emerging fully formed. The average number of young in one brood pouch is 23, 13 of which may be born one day and 10 the next; or only seven may be born in one day and no more for five days. (Bibliography No. 195.)

The natural food of *Gammarus* is decaying vegetation. In captivity they eat aquatic plants, lettuce, microscopic particles gathered from the bottom mud, macerated clam, meat and fish; also, they are fond of live *Daphnia*.

They swim back down, carrying their food about until they find a convenient place to suspend themselves by one or two of their numerous feet and eat it. They are hardy and in the wild ponds do not hibernate in winter but merely sink to deeper water during freezing weather.

They will last an hour in sea water, remaining active for about 25 minutes—long enough for Sea Horses to capture them. In brackish water they will survive for two hours or longer.

Salt-water *Gammarus* (*G. locusta*) infest the leaves of sea lettuce.

209. What is the life history of *Artemia salina*, the brine shrimp?

Dry mud containing the eggs of *Artemia* has been sent from America to England and from Algiers to France, and the eggs have hatched when placed in salt water. It is said they will withstand three years of desiccation. *Artemia* are said to be the only animals that flourish in the Great Salt Lake. They are found also in the Dead Sea and in brine pans all over the world. The eggs persist after the evaporation of all water and when only salt remains. When the salt is dissolved, they hatch. For some generations both sexes are numerous, alternating quickly with other generations which contain only parthenogenetic females (those which reproduce without the males). *Artemia* swim back down, like *Gammarus*, and the new-born young, like those of *Gammarus*, measure one mm. in length.

In the Great Salt Lake the brine shrimps eat the brown algae which are common there. In the Pacific, their food probably is similar. Mr. Alvin Seale has found that they will eat powdered fish meal. The eggs, now shipped from California to the eastern states, are hatched in salted water to serve as live food for toy tropical fishes. In a strong salt solution, made by using four tablespoons of salt to the pint of water, they will hatch in 48 hours or less at a temperature of 70°. Some of the eggs do not hatch for three or four,

days, and it is advisable to have one or two jars for them in order to allow some to remain for a longer period. If placed in sea water which has stood long enough to accumulate brown algæ, the young last longer. In fresh water they last for 12 hours or longer.

210. How can one breed maggots?

This is easily done in warm weather by placing a piece of raw meat in the sun to spoil, if one does not mind the odor. Flies lay their eggs on it and in a few days it will be wriggling with maggots. No food is more acceptable to little fishes of both fresh and salt water. With Goldfishes, Sunfishes and Killies they are especial favorites.

211. What is an *Asellus*?

An *Asellus* is a crustacean reaching a length of over one-half inch and found in both fresh and salt water. In fresh water it is called fresh-water sow-bug and hog louse. It is common in ponds everywhere, living in the mud. It is a shy creature, omnivorous, eating protozoa and decaying plant and animal substances. The female carries the eggs—50 or more—under her thorax until they hatch and is said to rear several broods a summer.

Asellus is eaten by many fresh-water fishes, including Sunfishes; and some salt-water fishes such as Slippery Dicks and other Wrasse fishes. The common newt also is fond of it.

212. What is a fairy shrimp (*Branchipus*)?

This is a delicate little crustacean of temperate climes, which reaches a length of one inch or more and swims, like *Gammarus*, back down. In fact, it swims most of the time, seldom settling (*Branchipus* is pronounced bran-kip'-us.) The name *fairy* derives from the lovely colors reflected in its nearly transparent shell.

The fairy shrimp is preyed upon by all little fishes residing in the same waters and is a decidedly choice morsel. The green frog also is very fond of it.

The fairy shrimp cannot be kept in captivity and must be netted. Therefore only those who can go out to the ponds collecting will be fortunate enough to use it for live food and only the number needed for immediate use should be taken. It seldom is seen except one looks expressly for it, and has a way of disappearing from ponds where it has been numerous.

Fairy shrimps die in the spring immediately after breeding. The eggs cannot hatch unless they are first dried and sun baked. Eggs, therefore, may be left in the mud of pools which are about to dry

up and will remain quiescent until rain fills the pools again. Or they may be blown about by wintry winds and deposited in new ponds. Therefore *Branchipus* may be found in large numbers in ponds formed by spring rains, for generally the eggs develop in the late fall or winter and the young attain their growth early in the spring. Also, it may be taken in the ponds in winter—from December to April, frosty waters seeming to suit its taste.

pH has no terrors for the fairy shrimp, for fragile creature though it is, it withstands drastic changes from acid to alkaline water.

It is a scavenger, living largely on decaying plant and animal substances.

213. What are glass worms?

The term "glass worms" is a wrong designation for the larvæ of a family of aquatic insects which are now known as *Chaoborus* (formerly *Corethra*). Entomologists call the glass worms "phantom larvæ."

One can collect glass worms by visiting the waters where they live—usually ponds which are surrounded by trees and which partly dry up. These larvæ will be found all winter in the latitude of New York, swimming horizontally just below the surface of the water; very active little creatures about seven-sixteenths of an inch long, with dark eyes, two dark spots on the thorax and two near the end of the abdomen. These are air sacs. In March they turn to pupæ and then float head up like a mosquito larva breathing air through the respiratory trumpets on the top of the head.

In the larval state they feed on *Daphnia*, fish fry, mosquito larvæ, and probably one another. Entomologists know very little about them, but some aquarists who have collected them have observed what appears to be a little hook on the head for capturing the prey.

214. What is a wax-worm?

Wax-worms are the larvæ of bee-moths which infest bee hives and are of two genera—the larger, *Galleria mellonella*, and the lesser, *Achroia grisella*. The larger is more common. Bee-moths enter a hive and lay their microscopic eggs. Here the minute young caterpillars (wax-worms) hatch and begin immediately to spin a tough silken roof over the cells, under which they crawl about eating the wax and destroying the young bees. Spinning is accomplished with great rapidity, an adult worm being able to spin itself a roof over one cell in from 10 to 15 seconds. They are the only animals known to feed on wax.

The larger wax-worm (*G. mellonella*) is a soft, juicy grub, about one inch long at maturity, greatly relished by fishes, salamanders, lizards, turtles, frogs, toads and other aquarium and terrarium animals. It is used at the National Zoological Park (Washington, D. C.) as live food for such small animals.

The segmented body is grayish white with dark "innards," the head a brownish red. Wax-worms are found throughout the world and everywhere in the United States except in the Rockies. Every apiarist is familiar with them.

In the pupal stage, a heavy white cocoon completely encloses the body. The larger bee-moth is one-half inch in length and has long outward-turning antennæ. The smaller is slightly larger than a house moth. Both are of a nondescript yellowish brown. They are distinctly nocturnal. (Bibliography No. 88.)

215. How can one feed with wax-worms?

Wax-worms are sold to responsible persons who will not allow the moths to escape. Old honeyless combs containing wax-worms or their eggs can be purchased from apiaries, especially during summer. If kept in a wooden box they may be bred indefinitely, but they require warm quarters. Both worms and moths can work their way through paper, cloth, and soft cardboard. The box should be about 14 or 18 inches square and should be kept dark as well as warm, with a tight cover and wire screening either over small holes here and there, or with a four inch width of wire screening on each side near the top.

One will know when the worms have hatched by the silken threads spun over regular rows of cells, looking like little cloisters. The start is very slow, but once the culture is established, it is worth while. The worms are alert, nervous animals, and will drop to the bottom of the cells if aware of an intent to capture them. They may be extracted with a small forceps. The food they eat causes them to float and they are especially desirable for surface-feeding fishes such as Cyprinodonts and the *Pantodon*.

216. What are diatoms and desmids?

Diatoms and desmids are microscopic free-moving plants which help make up the floating algæ that form the scum on ponds and on hay infusions, and are eagerly sought by fish fry of all kinds. Diatoms are shelled and are abundant in both fresh and salt water. The shells sometimes are beautifully patterned and are favorite objects for microscopic study. Diatoms can survive for 25 years in

their natural environment, even though frozen in ice; but they cannot withstand desiccation (not reviving after being dried).

Diatoms and desmids, as unicellular (one-celled) plants, occupy a place in the plant kingdom nearly corresponding with that of the protozoa in the animal kingdom, these also having but one body cell.

Desmids and diatoms are more active during bright daylight.

217. What are rotifers?

Rotifers are grouped zoologically under the name of Trochelminthes, meaning wheel worms; nevertheless zoologists generally deny they are worms and call them instead wheel animalcules; "wheel" because of the circle of cilia at the head end, which is constantly in motion, and "animalcules" because the animals are microscopic. They are highly organized and some have shells. They swim by means of the cilia and some creep like leeches. The majority have forked tails which can be retracted.

Rotifers are abundant in ponds and ditches and females are more common among them than males. They resemble *Daphnia* in this respect. The males are only one-fourth the size of the females. After the eggs are laid they become attached to the base of the tail of the female and are carried by her until they hatch. There are two sizes of eggs, the smaller developing into males, the larger into females. As in *Daphnia*, thick-shelled winter eggs are produced which in the spring hatch into females. Some rotifers give birth to living young.

218. What is an infusorian?

Infusorians form one of the five classes of protozoans or one-celled animals and are called also "ciliated protozoa" because of the cilia with which they are provided either through life or in the young stage.

• Cilia are fine, hairlike processes which are constantly in motion and help the animal to move about, also assist it in whirling smaller animals and plants in its direction, to serve as food.

Infusoria eat floating algæ, desmids, diatoms—and one another.

219. If infusoria have only one cell and no organs, how can they multiply?

They multiply very rapidly by dividing themselves in two and each part goes on dividing until there are millions.

220. How can infusoria and other animalcules be reared for infant fishes?

A powder now is on the market for breeding infusoria. The older method was to place a handful of hay in a bowl or basin, cover it with water and allow it to stand in the dark for nearly a week. The mixture darkens as it ripens. In two days a few thousand infusoria have appeared, in four days myriads, and in seven days their number is beyond calculation. They become thick for one or two inches below the surface and are representative of many species. About the ninth day the surface scum may be filled with common rotifers also.

If dried lettuce is used in the same way, rotifers will appear on the ninth day, but infusoria never are as thick as in a hay infusion. Fresh lettuce is used to produce microscopic food for *Daphnia* (see No. 203), also banana skins laid in water.

If bowls are started at intervals of a few days for a week or 10 days, the fry will be well provided for. When the mixture is "ripe," a cupful or less can be dipped out into the aquarium and the fry will be observed capturing their prey, their tiny eyes being able to perceive objects invisible to us. Some aquarists start their infusoria culture as soon as the parent fishes are in condition for breeding.

A good incidental medium for the cultivation of infusoria, if it be allowed to remain in the aquarium, is the waste from oviparous snails—Pond Snails, Ramshorns, the Four-horned Snail, in fact all snails with large appetites. The viviparous snails are small eaters and not important in this respect.

If aeration is supplied, it will help to keep the infusoria culture sweet.

221. Why do infusorians and rotifers appear in hay or lettuce infusions?

These animals have the power to resist desiccation. They surround themselves with a firm, protecting membrane (called a cyst) and are blown about, remaining where they lodge until conditions prove more favorable. When moisture is encountered, they emerge and become active. Some species of protozoans have come to life after being encysted for 20 years. (Bibliography No. 147.)

222. When infusoria are fed to baby fishes five or more times a day, will the water become foul?

This may be prevented by using a larger tank, siphoning off from the bottom at least two quarts of water every third day and adding fresh water of the same temperature.

TROPICAL TOY FISHES

GENERAL INFORMATION*

223. What waters do tropical fresh-water toy fishes naturally inhabit?

The natural habitat of the pigmy fishes which now are swimming up and down the earth and round about it (in aquariums) covers a wide range in both Hemispheres. In the Americas, they are taken from the Carolinas south, through Mexico, Central America and South America to southern Argentina. They are found in the West Indies and in the East Indies. In the Orient, gorgeous specimens are gathered in Africa, particularly in Egypt; in Asia, including Indo-China, China, Ceylon, India, Siam and the Philippine and Samoan Islands, Zanzibar, the Malay Peninsula and Malay Archipelago; also in Australia.

224. How did the tropical toy fish reach the United States?

Through Europe, where Paradise Fishes and others were known over 50 years ago. Later, Germany began to import toy tropicals from South America and breed them, shipping them to the United States. It is only since the World War that South American fresh-water toy fishes have been collected for direct transport to North America; though Bermudian salt-water fishes were collected as early as 1862 for Barnum's Aquarial Hall in Boston.

Early in the 20th century, importations from Germany became frequent. In 1907, Herman Rabenau began business as the first importer of toy tropicals for commercial purposes in the United States.

Other pioneers were August Obermuller, most successful of the early breeders of toy tropicals in this country; C. J. Heede, who brought to the public a knowledge of Paradise Fishes, *Gambusia* and others by publishing what he knew about them as early as 1911; and Richard Dorn, who worked with tropicals, advocated them and sold them to spread the "hobby."

Toy tropicals now reach New York directly from Australia, Java, India, the Philippines and other distant lands, and are taken directly to San Francisco from all these places, as also from Samoa and Mexico.

* All temperatures in this book are Fahrenheit.

225. Where can an amateur aquarist obtain tropical fishes?

They are sold in most pet shops, also by private breeders in almost every large city and in hundreds of small cities. Members of aquarium societies often have stock to sell or exchange. Advertisements regularly appear in the aquarium journals.

226. How many toy tropicals should one introduce for each gallon of water in the aquarium?

This depends on the species, some pairs breeding successfully in one gallon of water, others requiring 10 or 15 gallons according to spawning habits and number of young. The air breathers live in small quarters and even in foul water, because of their habit of seeking the surface frequently to breathe air. The oxygen requirements of tropical toy fishes in general are far below those of other small aquarium fishes, and in a community tank as many as 24 toys will thrive in 10 gallons of water.

It must be remembered that a crowded tank creates bad feeling among its occupants. When mechanical aeration is supplied to help increase the oxygen, the number of fishes to the gallon can be increased to twice this figure.

Always leave plenty of space between the surface of the water and the cover.

227. How can one propagate live-bearing species?

With many species of peaceable egg layers it is the practice to use two males to one female to insure the fertilization of a higher percentage of eggs; but with some of the live-bearers (Guppies being a notable exception) only one male is used. Among Swordtails, for example, two males would fight. Fertilization usually takes place a few weeks prior to the birth, therefore it is not necessary to have the male in the same tank with the female when the young are born. Frequently among live-bearers the females remain fertile for some months after giving birth to one family, producing young regularly though there is no male in the aquarium with them.

The smallest live-bearers can be propagated in the home aquarium if kept by themselves.

228. Which species are best for keeping down the algæ in the tropical fish aquarium?

Some live-bearers are algæ eaters, as the *Limias*, Mollies, Guppy, *Girardinus metallicus* and Brackish Water Millions; also numerous egg layers, as the American Flag Fish (*Jordanelia florida*), the

Gouramis, particularly *Colisa lalia* and the Three-Spot Gourami, and Australian Rainbow Fish.

229. Which are the best plants for catching the eggs of toy tropicals?

Nitella, *Myriophyllum*, *Sagittaria*, *Fontinalis*, *Vallisneria*, *Ludwigia* and *Cryptocoryne*. *Riccia* and water hyacinth roots also are used.

230. Name a few egg layers easy for a beginner to raise.

Rosy Barb, Zebra Danio, Tetra from Buenos Aires, Silver Tetra, *Panchax chaperi*, Fighting Fishes and *Rivulus tenuis*. The Paradise Fish also is easily reared. With ill-natured species, only one male is used with each female. (See No. 227.)

231. Name a few live-bearers easy for a beginner to raise.

Nearly everyone begins with the Guppy. Others easy for the novice to rear are the Mexican Swordtail, Moonfishes, and the Top Minnow (*Heterandria formosa*).

232. Which tropical fish is the hardiest?

Most fish fanciers regard the Paradise Fish (*Macropodus opercularis*) as the hardiest. It has been transferred to outdoor pools and withstood almost freezing temperatures. It is also one of the most intelligent of toy fishes, which may atone for a bad disposition.

233. Which are the most beautiful of toy tropicals?

The Veiltail *Bettas*, African Jewel Fish, Paradise Fish in the breeding season, Dwarf Gourami and Red-breasted Cichlid are among the most beautiful.

234. How long is it possible to leave toy tropicals without food?

In most cases they should not be allowed to go without food for over a week or 10 days, but some species which are largely herbivorous thrive indefinitely on the algæ picked from leaves and glass. This applies particularly to live-bearers.

35. What is the best food for toy tropicals?

Many good specimens have been reared on powdered foods when a variety of these has been used, but if possible to include live food twice a week, this is an excellent plan.

Chopped earthworms make a desirable food, particularly when a fish is not well.

Raw fish, whether from fresh or salt water, is an ideal food.

Nearly all live-bearers are omnivorous and should be provided with some form of vegetable food, prepared foods, as well as brine shrimps, or similar live food, and chopped worms. There should be plenty of soft plants in the aquarium and also sufficient light to stimulate the growth of algæ.

(See also Foods of Fishes, Nos. 187-189 and Goldfish foods, Nos. 664, 665 and 667.)

236. How often should toy tropicals be fed?

Once a day, especially those which are not algæ eaters. Twice a day is better during warm weather.

237. What is the minimum temperature at which toy tropicals should be kept?

A temperature of 75° is considered the lowest at which the majority will thrive. Many do well and even breed at house temperatures (68° to 72°) but they breed more rapidly at higher temperatures. For breeding and for developing the young, temperatures of from 80° to 85° are best, and some species like the water still warmer. Some survive without discomfort at a temperature of 100° but few do well if the water is warmer than that.*

238. What points should one consider in building a conservatory for exotic fishes?

The main points to consider are lighting, ventilation, and control of temperature. (See illustration of modern commercial toy fish hatchery.)

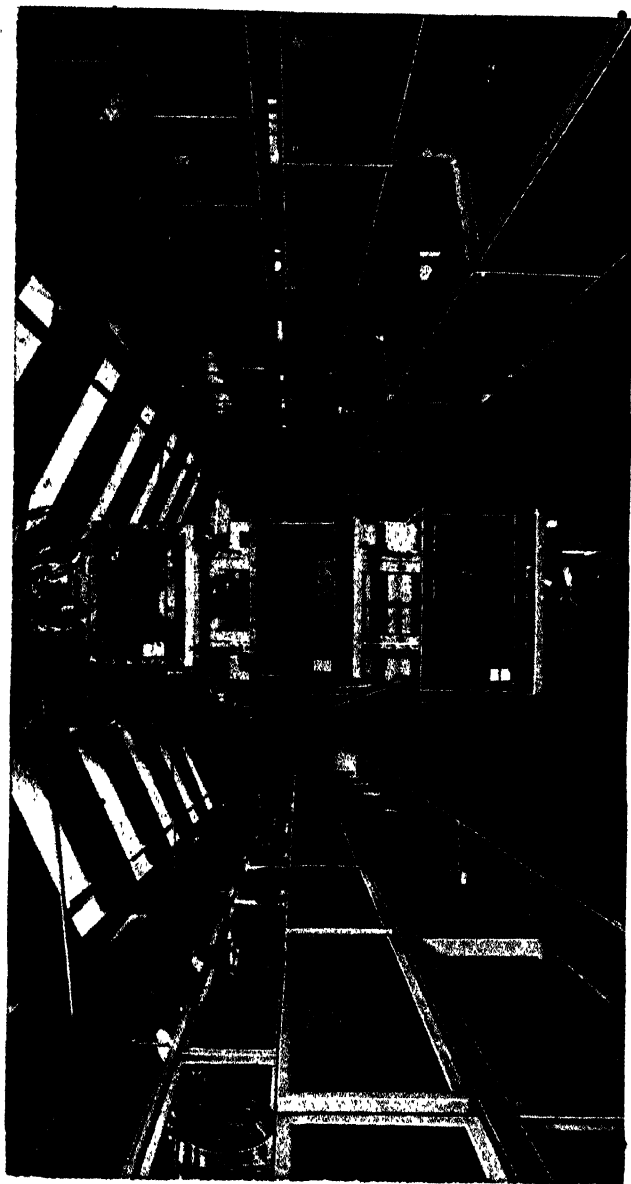
239. Name some toy tropicals which will breed in the temperature of the living room, i. e., 68° to 72°.

The Paradise Fishes, Guppy, *Panchax lincatus*, Medaka, Rosy Barb, American Top Minnow, American Flag Fish.

240. Name some toy tropicals which can be maintained in living-room temperature, i. e., 68° to 72°.

The *Pantodon*, Mollies, Platys, Chanchito, Channa, Climbing Perch, Black-banded Chromide, Spotted and Zebra Danios, etc.

* All temperatures are Fahrenheit.



• A Modern Tropical Fish Hatchery

The building, which is 12' x 35', x 14' high, is provided with 15 doubly glazed skylight, arranged in staggered system for the equal distribution of light. Each skylight is 2' x 4', with a five-inch air space. A hot water system provides general heat, with no individual appliances. Ventilation is accomplished by three air ducts, each 4' x 14', which receive the air from outside the building, convey it to the floor and liberate it past the heating pipes. Foul air and humidity are expelled through four ventilators, each 12" x 12", situated at the peak of the building. Tanks are arranged in steps, construction is of angle iron, total weight of equipment ~~24~~ tons.

ramis, Bloodfin, Blue *Panchax* and those named in the preceding answer.

241. When is the best time to select toy fishes for breeding?

About October. Choose the best young specimens, give them a 10 gallon tank, and keep the sexes separate, if possible, when signs of maturity appear.

242. When is the best season for breeding toy tropical fishes?

Best results are obtained during spring and summer, but healthy live-bearers, if well fed and kept at the proper temperature, will breed at any time. It is customary to separate the sexes among egg layers during the conditioning period and to mate them when the females are heavy with spawn. Fishes, during the conditioning period, should be given rich foods, preferably live foods.

243. At what age is it safe to transfer young fishes from the tank in which they were hatched?

When they are nine or 10 weeks old.

244. How long do tropical toy fishes live in captivity?

At the present time, two members of the Cichlid family have been in captivity in the Steinhart aquarium for more than eight years, another for 10 years (*Cichlasoma biocellatum* and *Pterophylum scalare*). Many others now are in their fifth year. Paradise Fishes not infrequently survive for eight years in captivity, and the Sedate Cichlid and Climbing Perch for upwards of 10 years. According to Innes, the Striped Gourami has survived for eight years, and a *scalare* in Germany has lived 18 years in captivity. The average survival under proper conditions usually is between one and two years. (See also No. 256.)

THE COMMUNITY OR "HAPPY FAMILY" TANK

245. Is a community tank desirable for tropical toy fishes?

The community tank affords a splendid opportunity to become acquainted with a number of species, and for the small home is desirable in that respect. Largely it is a matter for personal decision, to suit personal taste.

Often it has been noticed that when new fishes are introduced into a community tank, they die. The water, perhaps, is not the same as that from which they came, or the presence of certain other fishes may be inimical to them for reasons not easily understood.

For the best showing of color, grouping of one species is necessary, the same as it is with flowers or jewels, and the experienced aquarist understands this quite as well as do the gardener and gem expert. This is particularly true because when a number of fishes are of one species, they tend to school. A tank stocked with one or two brilliant species each schooling by itself creates a more striking display than a community tank in which uniformity of brilliance is lost. One pair of Red Platys in a community tank will hardly be noticed, but a school of 40 is a sight never to be forgotten.

Nevertheless, where space is not sufficient to maintain as many tanks as one would like, the community or "happy family" tank is the answer to the problem. A 20 gallon tank will be found ideal for this purpose and is easily maintained provided not too many fishes are placed together. Care should be taken to select those which get along well together and are of approximately the same size.

246. Will toy fishes breed and cross-breed in a community tank?

They will breed, but most of the young will be eaten. If the tank is sufficiently well planted to provide a refuge, some will survive. They rarely cross-breed if pairs are in the same tank. Some, though not all live-bearers, however, are apt to cross-breed.

247. Which are the best species of toy tropicals for a happy family tank?

It is impossible to list them all, one book having been published which describes 75 kinds—showing the large number of available species which are peaceable.

The 26 kinds listed below will do well together and provide an interesting display of color:

Flag Tetra	Dwarf, Catfishes
Snake Tetra	Fresh-water Angelfish (<i>scalare</i>)
Red Mouthed Tetra	Top Minnow (<i>Heterandria formosa</i>)
• Bloodfin	Zebra Fish or <i>Rerio</i>
Red Tetra from Rio	Pearl Danio
Head and Tail Light	Spotted Danio
Riddle's Tetra	<i>Rasbora heteromorpha</i>
Swordtail Characin	Elegant <i>Rasbora</i>
Hatchet Fishes	Chaper's <i>Panchax</i> • •
Gouramis	Flying Barbs (<i>Esomus</i>)
<i>Nannostomus</i> genus	Everett's <i>Barbus</i>
Guppy	<i>Barbus phutunio</i>
Moonfishes	Glass Fish (<i>Ambassis lala</i>)

248. Which species of toy fishes should be particularly avoided in stocking a community tank?

These also are numerous and include Paradise Fishes, *Gambusia*, the Jewel Fish and many other Cichlids, the Rosy and Striped Barbs and some other Barbs, *Belonesox*, many of the genera *Panchax* and *Fundulopanchax*, *Jordanella floridæ*, *Dormitator maculatus* and *Notopterus notopterus*. The Fighting Fishes do well with other species, but when two males are present in the same tank, they will battle until one is killed.

EGG LAYERS

249. What is a Characin?

The word Characin (pronounced Kar-a-sin) is from the Greek *charax*—sea-fish; but as with many other fishes, the family name is associated, not with the habitat of the fish, but with certain anatomical peculiarities not always visible in life: for example, the teeth, the development of the brain case, and the placing of the air bladder in communication with the auditory apparatus as these occur among Characins. For the amateur aquarist we can do no better than group together the fresh-water species of toy fishes belonging in this family, which come from Mexico, Trinidad, Central and South America, Egypt, and other parts of Africa. Eigenmann estimated that the Characins form one-third of the entire South American fish fauna. They have played a prominent rôle in Africa since ancient times and pictures of Characins may be seen in the mural decoration of graves near the Pyramids. In Trinidad the Characins are called "Sardines."

The great family of Characiniæ embraces species which live only in clear mountain streams, and species which favor shallow, muddy water. It comprises both mild and bloodthirsty members, and fishes of all shapes and sizes, many brightly colored. These range from the gentle Hatchet Fishes and other small favorites of the amateur aquarist to the terrible Piranhas of South American tropical rivers and of many species, best known of which are *Rooseveltiella niger* and the Serrasalmos—*Serrasalmus rhombeus*, *S. spilopleura*, and others.

Piranhas were made famous by Theodore Roosevelt, who described vicious attacks upon members of his party by the species now bearing his name. For a long time afterward the fish was known as "cannibal fish" because it attacks human beings (though a cannibal is an animal which preys only on its own kind and no one



SIX WELL KNOWN CHARACINS FOR HOME COLLECTIONS OF TROPICALS

Upper left: Red Tetra or Tetra from Rio (*Hyphessobrycon flammeus*). Upper right: Rosy Tetra (*H. rosaceus*). Center left: upper fish, Ring Tetra (*H. heterorhabdus*). Lower fish, *Nannostomus tetras*. Lower right: Tetra from Buenos Aires (*Hyphessobrycon callis*). Lower center: Bloodfin (*Aphyocharax nattereri*).

ever had thought of calling a man-eating Shark a cannibal fish). Other names are Caribe and Perai. This species attains a length of 18 inches. The smaller Piranhas may reach one foot. Piranhas have sharp, trenchant teeth for destroying flesh and in their native waters attack any living thing they meet, regardless of size. Motion pictures have been made to illustrate how Piranhas, within a very few minutes can reduce to a cleanly picked skeleton an animal many times larger than themselves.

250. What are the breeding habits of the Characins?

The small adhesive eggs are deposited everywhere among the plants and sometimes on the glass and stones in the aquarium. Some Characins are easily bred, others with difficulty. If the male is vigorous, only one is needed but often the best results are obtained by using two males to each female.

TETRAS AND HATCHET FISHES

(FAMILY CHARACINIDÆ)

251. What are the distinguishing features of the Tetras?

Two-thirds of all the Characins, including many but not all the Tetras, are distinguished by a small second dorsal, called the adipose fin and located near the base of the caudal.

Numerous modifications occur among the Tetras, age, season, food, sex, habitat and water temperature producing alterations in bodily shape, number of scales and fin rays.

252. What is the habitat of the Tetras?

They range from Texas to southern Argentina, and some are found on the island of Trinidad.

Riddle's Tetra is indigenous to the island of Trinidad, and is abundant also in British Guiana, where many specimens have been taken in the Botanic Gardens.

The Tetra from Buenos Aires is taken in Argentina, its abundance in and about Buenos Aires giving it its common name.

253. What is the best way to breed Tetras?

The breeding tank should be one of at least five gallons' capacity, and for the larger species 10 or even 15. It should be well planted with *Nitella*, *Myriophyllum*, *Riccia*, *Cabomba* and *Anacharis*. The,

number of eggs varies from 50 to 200 at each spawning, depending on the size and age of the breeding pairs, active, vigorous specimens producing the largest number. They are clear and transparent and will hatch in about three days at a temperature of 78°. The parents should be removed as soon as the eggs are noticed on the plants, as they will eat both eggs and young.

The temperature of the water generally should be 75°, raised to 80° for spawning. The young are almost transparent, and adhere to the plants and sides of the tank for two or three days until their yolk sacs are absorbed. They should be given infusoria or very fine prepared food the second day after hatching. When they reach their third week they will take newly hatched brine shrimps or similar live food and larger prepared foods.

254. What food do Tetras require?

Most Tetras take prepared foods but prefer live foods such as Daphnia, enchytræids, garden worms and brine shrimps. They like scraped beef and shellfish.

255. What is the disposition of the Tetras?

Some are peaceable, some not. For the community tank, we recommend the Bloodfin, Riddle's Tetra, Lined Tetra, Red Mouthed Tetra, Little Tetra, Spot Tetra, Rosy Tetra, Red Tetra, Flag Tetra and Blue Tetra.

Tetras with bad dispositions, which annoy smaller fishes and destroy aquatic plants are: the Yellow Tetra, Tetra from Buenos Aires, Glass Tetra, Black Striped Tetra, Tetras of the genus *Metynnis*, and the Two-spotted Tetra.

256. How long will Tetras survive in captivity?

The Blue Tetra does not commonly survive over one and one-half to two years; the Yellow Tetra, Tetra from Buenos Aires, Head and Tail Light and Riddle's Tetra may last for three years; the Red Tetra, Glass Tetra, Lined Tetra and Silver Tetra have survived for four years; and the Two-spotted Tetra, Bloodfin and Black Striped Tetra have a record of five years' survival. *Metynnis maculatus* has lasted 11 years.

257. What are the colors and breeding habits of the Rosy Tetra, *Hyphessobrycon rosaceus*?

The striking feature of this beautiful, hardy, well-behaved fish from the Amazon Basin is the rosy hue overspreading the entire

body and reflecting a silvery sheen. The dorsal, ventral and anal fins are tipped with white, the dorsal having a large black spot. All fins except the dorsal are deep red, and the caudal lobes have reddish brown margins. An adipose fin is present.

The breeding habits are believed to be the same as those of the Red Tetra. (No. 259.)

The average length of this species is one and one-half inches, and it is distinguished from the Red Tetra by its larger size and the presence on the dorsal fin of a creamy white section spotted with black. The male's dorsal is larger and the female's shows a white edging tipped with red.

258. What are the colors and breeding habits of the Yellow Tetra, *Hyphessobrycon bifasciatus*?

The colors vary greatly in this Brazilian species, though commonly the fishes are light olivaceous, darker on the back and silvery on the belly. Just behind the gill covers are two vertical lines. A variable number of light wavy markings adorn the sides and a yellowish sheen covers the entire body. The fins of the male are brassy, while those of the female are clear, and his ventrals are larger. An adipose fin is present in this species.

The Brass or Bronze Tetra is apparently not a different species, but a color variation of *H. bifasciatus*.

The breeding habits are similar to those of the Red Tetra (No. 259), though the disposition is not as good.

The average length is a little over two inches. The female has a broader body than the male.

259. What are the colors and spawning habits of the Red Tetra from Rio, *Hyphessobrycon flammeus*?

The body, especially the posterior section, has a diffused reddish glow, two dark vertical lines on the sides and a less distinct spot behind the gill covers. A dark vertical bar crosses the eyes. The dorsal, anal and caudal fins are a bright red, deeper in the male. The anterior tip and lower edge of the anal fin are jet black in the male, and this fin is beset with tiny hooks which cause him to catch in a net. The ventrals and pectorals in both sexes are orange, except that in the male the ventral is reddish. An adipose fin is present in this species.

The eggs are deposited among the plants, where they adhere until hatched—in about three days. From five to 10 or more are expelled until 70 to 200 have been produced. The young hang on

the plants for two days or longer, and should be fed infusoria or fine prepared foods as soon as they become free swimming.

The habitat is southeastern Brazil, the disposition is good, and the species has survived for four years in captivity.

The average length is one and one-half inches, the female being larger at maturity than the male. It is a hardy and active fish.

260. What are the colors and breeding habits of the Spot Tetra (*Hyphessobrycon serpæ*)?

The body is a silvery white, reflecting a light golden orange. A black shoulder spot is always present and the dorsal fin has a large irregular black spot edged with white. The first ray of the anal is white. The dorsal and anal fins are orange. An adipose fin is present in this species. The female fish is much broader than the male.

The habitat is the Amazon Basin, the breeding habits are believed to be the same as those of the other Tetras, and the species is a hardy one, with a good disposition.

The average length is one and one-quarter inches.

261. How is the *H. serpæ* distinguished from the Rosy Tetra (*H. rosaceus*)?

H. serpæ is a little smaller though otherwise similar in shape. The body color is bright red, this color spreading into the fins. The tips of the fins have pearly white edges except the posterior part of the anal, which is edged with black. The Rosy Tetra is reddish or pale yellow, the male's dorsal fin is larger and that of the female shows a reddish tip above a white edge.

262. What are the colors of the Little Tetra, *Hyphessobrycon minor* (or *minimus*)?

This species resembles the Rosy Tetra and comes also from the Amazon Basin. An adipose fin is present.

The breeding habits are said to be the same as those of the Red Tetra. (See No. 259.) The disposition also is mild.

Like the Rosy Tetra, it is not abundant at this time, but is active and robust. It attains a length of one and one-quarter inches and is distinguished from the Rosy Tetra by its smaller size. Also, it has a black shoulder spot, and the body is not as red as that of the Rosy Tetra, but reflects more of a brassy sheen, and there is a greenish black spot behind the gill openings.

263. What are the colors and breeding habits of the Tetra from Buenos Aires (*Hemigrammus caudovittatus*)?

The back is a light olivaceous, the sides are silvery and reflect a yellowish sheen. A large black diamond-shaped spot located at the base of the caudal extends to the end of the tail. The fins are almost transparent except the dorsal and caudal, which are a light orange, richer in the male. An adipose fin is present in this species. The females are much more rounded, especially during the spawning season.

The breeding habits are the same as those of the Red Tetra. (See No. 259.) The number of eggs at one spawning varies from 80 to 150 or more.

A maximum length of nearly four inches is reached, the average being about two and one-half inches.

This Tetra gets along better with fishes of its own kind, but can be kept in a community tank with specimens of its own size. It will last about three years under suitable conditions.

264. What are the colors and breeding habits of the Red Mouthed Tetra, *Hemigrammus rhodostomus*?

Color of back, a rich green, sides grayish and ventral region light yellow. A dark stripe extends from the red shoulder spot to the caudal fin, where it is wider. The upper and lower lobes of the caudal fin have alternate ivory and black markings. The forehead is a rich red. An adipose fin is present. The body is shaped like that of the Tetra from Buenos Aires but is not as deep.

The breeding habits are believed to be the same as those of the other Tetras. The habitat is the Basin of the Amazon.

The length averages about one and one-half inches, and the disposition is good.

This species was not abundant in United States aquaria until early in 1934.

265. What are the colors and breeding habits of the Head and Tail Light (*Hemigrammus ocellifer*)?

Body silvery, with a brassy sheen. The reddish copper spot at the base of the caudal and the red eyes reflect the light in a fascinating manner, hence the common name. The adipose fin is present in this species. The male's dorsal fin is pointed, there is a light spot on his anal fin, and he has a more slender body than the female.

The breeding habits are the same as those of the Red Tetra. (See No. 259.)

The average length is about one and one-quarter inches.

The habitat is the Basin of the Amazon.

The record of survival in captivity is three years.

266. What are the colors and breeding habits of the Lined Tetra (*Hemigrammus unilineatus*)?

In this Tetra, which comes from the island of Trinidad, the body is a light greenish blue, reflecting a silvery sheen. The upper edge of the dorsal fin bears a dark spot bordered with white. The first rays of the anal fin are traversed by a black slanting line which is edged with white. A glossy lateral line extends from the gill covers to the base of the caudal. The unpaired fins are a rosy color and sometimes the tail is edged with black. An adipose fin is present in this species.

The breeding habits are the same as those of the Red Tetra, but a larger breeding tank is recommended. The eggs hatch in about three days. This fish is hardy and a prolific breeder.

The average length of the male is one and one-quarter inches, of the female one and one-half inches, the disposition is good, and the species has survived for four years in an aquarium.

267. How is *H. unilineatus* distinguished from *Pristella riddleyi*?

H. unilineatus is larger and has a straight black and white line on the front edge of the anal fin. The dorsal and anal fins of *P. riddleyi* are yellowish and have distinctive dark spots anteriorly.

268. What are the colors and breeding habits of the Flag Tetra (*Hyphessobrycon heterorhabdus*)?

This Tetra, from the Amazon Basin and Paraguay, has a body which reflects a greenish silvery sheen. A horizontal white stripe extends from the gill cover to the base of the caudal. This stripe is bordered with red below and blue above, the combination of red, white and blue having given the fish its common name, for although the stars are absent, the stripes are there. All the fins are clear and transparent, sometimes showing a light yellowish tint. An adipose fin is present in this species.

This Tetra is considered difficult to breed. One California aquarist who has bred it successfully recommends the same treatment as for the Red Tetra. (See No. 259.) The disposition is good.

The average length is nearly one and one-half inches. The male has hooks on his anal fin which cause him to catch in a net and it is better to use a dipper or cup in removing him.

269. What are the colors and breeding habits of the Glass Tetra (*Moenkhausia oligolepis*)?

The body has a dull luster. A black spot covers the anterior portion of the caudal and is gradually diffused through the fin. The dorsal, adipose and ventral fins are reddish orange to lemon. Shoulder spots are sometimes visible and the base of the caudal has a glassy sheen.

For breeding this species a large, well-planted tank is necessary. The habits are similar to those of the Red Tetra. (See No. 259.)

The average length is about three inches, maximum four.

The male's ventrals are longer and the outer edge of his anal is concave. The female has a more rounded body. The disposition of this species is not good.

The habitat is Brazil. Under proper conditions it has made a record of four years' survival in captivity.

270. What are the colors and breeding habits of Riddle's Tetra, *Pristella riddlei*?

The body is silvery and almost transparent. The caudal fin has a reddish tint and sometimes the ventrals show a small dark spot. The dorsal and anal are light yellow and both have a distinct dark spot anteriorly. The caudal fin is more flushed with red during the breeding period. An adipose fin is present in this species.

The breeding habits are the same as those of the Red Tetra. (See No. 259.) The eggs are minute and hatch in 36 to 72 hours. The young when hatched are very tiny and the smallest of infusoria should be supplied on the fourth day. Sexes are difficult to distinguish except by the swimming bladder, which is visible. In the male it is pointed, in the female it is round and located higher in the body.

This species is hardy, but likes the water about 82° for breeding.

The average length is about one and one-quarter inches.

Its small mouth makes fine food necessary, the disposition is mild, and individuals may last for three years in the aquarium.

271. What are the colors and breeding habits of the Bloodfin, *Aphyocharax rubripinnis*?

In body form it resembles somewhat the Pearl Danio. The body is silvery with blue, green, violet and reddish sheen. A grayish silver line extends from the gill covers to the base of the caudal. All fins except the pectorals and adipose are blood red, hence the name.

The Bloodfin propagates well when two males are placed with one female or two females with three males. A well-planted tank not over eight inches deep and of at least 10 gallons' capacity should be provided because of this species being a communistic breeder. The eggs are non-adhesive and almost transparent.

The Bloodfin averages two inches. The sexes are immediately distinguished by the more rounded, bulky body of the female.

The male has a tiny hook at the tip of his anal fin which is not seen with the naked eye, but when taken in a net this little hook causes him to catch in and adhere to the net while the female remains free. It is therefore better to use a cup or dipper, if possible, in transferring Bloodfins.

The habitat of this species is Argentina.

The disposition is good, and it is extremely hardy, having a survival record of five years.

272. What are the range and habitat of the Black Striped Tetra, *Astyanax fasciatus*?

This species has a rather wide range. It is found from southern Mexico south through Central and South America, ranging coastwise in Brazil and on the Pacific side from Panama to Ecuador, where it lives in swamps and ditches.

273. What are the colors and breeding habits of the Black Striped Tetra?

This is a very variable species in size and color. Usually the body is silvery olivaceous, darker green along the back. A metallic greenish luster forms a stripe which extends from just below the dorsal fin to the center of the caudal fin. This stripe is darker at the caudal. All fins are tinted with light yellow or green. The male is more slender and his dorsal is yellow. An adipose fin is present.

Propagation is the same as in the Silver Tetra. (See No. 276.) From 75 to 250 eggs may be produced at one spawning in a temperature of 78°. A large tank should be provided.

The length attained by this species is two and one-half to four inches. It is exceedingly hardy and has survived for five years in captivity. The disposition is not good, however.

274. What are the colors and breeding habits of the Two-spotted Tetra, *Astyanax bimaculatus*?

The color of the back is light fish green, sides silvery or brassy. Just back of the gills is a black spot, surrounded by a light area. A

diamond-shaped black spot is present on the caudal peduncle. The fins are hyaline. Dorsal, caudal and anal of male are brassy to reddish. His dorsal is pointed and his colors much brighter than those of the female. An adipose fin is present.

The breeding habits are the same as those of the Silver Tetra, (No. 276.) From 100 to 350 eggs are produced at one spawning in a water temperature of 78°. This species is hardy, surviving for five years in captivity.

The average length is two and one-half inches, maximum five. The range is from Venezuela to Buenos Aires, and in its home waters it is an assiduous hunter of mosquito larvæ. It is savage and will rip the fins of other fishes.

275. How is the Two-spotted Tetra, *A. bimaculatus*, distinguished from the Black Striped Tetra, *A. fasciatus*?

Bimaculatus is much darker and more brassy than *fasciatus* and has a distinct shoulder spot.

276. What are the colors and breeding habits of the Silver Tetra, *Ctenobrycon spilurus*?

The silvery body has a bluish green sheen. There is a large black spot just behind the gill covers and a smaller one at the base of the caudal. All the fins have a light yellow or greenish tint, an adipose fin being present in this species. The female can be recognized by the reddish tint on the tip of her anal fin.

From 100 to 400 eggs may be produced at one spawning, at a temperature of 78°. A tank of at least 15 gallons' capacity should be provided, well planted and placed in a sunny location to induce the growth of algæ. Remove the adults as soon as the eggs are seen.

The average length is two inches, maximum three. The male is shorter and more slender than the female.

Silver Tetras range through northern South America. They are very active, darting playfully at one another and at other fishes. Smaller ones can be kept in a community tank. They are hardy and individuals have survived for four years in an aquarium.

277. What are the colors and breeding habits of the Silver Blue Tetra (*Glandulocauda inequalis*)?

The body of this Brazilian species is silvery with a bluish sheen, the back dark olive, and a dark spot is located just behind the gill cover. On the caudal base are two brown spots. The dorsal and anal fins are transparent but have two colored margins, the inner

brown and the outer gray. The caudal fin is a golden brown edged with black. The fins of the male are a little larger and his caudal fin is peculiarly notched as if a small piece had been cut out of the lower edge of the upper lobe. An adipose fin is present.

This species breeds at a temperature of 78°. It is said that the pair press their bodies closely together and the eggs are fertilized before being expelled. The adults must be removed as soon as the eggs are seen. The number varies in each batch from 40 to 150, and they are laid, a few at a time, under the leaves of plants, to which they adhere. They hatch in about two days, and the young must be given infusoria or very fine prepared foods. A tank of at least 10 gallons' capacity, well planted with *Sagittaria*, *Vallisneria*, and *Cryptocoryne* or *Ludwigia* should be provided.

This species somewhat resembles the typical Tetras, but the body is heavier and longer. Due to the peculiarly shaped upward turning mouth, it is difficult for the Silver Blue Tetra to pick up food from the bottom of the aquarium.

The average length is two inches, the female being a little larger. It is a fairly peaceable species.

278. What are the colors and breeding habits of the Blue Tetra, *Mimagoniates microlepis*?

The back is light olivaceous and the belly silvery white. A dark blue glistening lateral line beginning at the center of the body becomes wider and darker as it reaches the caudal base. The fins have a greenish tint, and dorsal and anal are bordered with orange. The caudal fin of the male is peculiarly notched as if a small piece had been cut out of the lower edge of the upper lobe. An adipose fin is present in this species.

The breeding habits are the same as those of the Silver Blue Tetra. (See No. 277.) The habitat is Brazil.

The average length is about two and one-half inches. The disposition is good. Two years appears to be the maximum survival.

279. What are the colors and breeding habits of *Metynnis roosevelti*?

The back is olivaceous, gradually shading into a light greenish silver in the ventral region. The ventrals are tinted with orange and the anal fins a bright orange red. The male is more brightly colored than the female and his anal fin is concave, the female's being straight. Two dozen or more almost round greenish olive spots are seen on the sides. The compressed body is deep and rounded, almost diamond shaped. The adipose fin is large.

This species breeds at a temperature of 82° and is said to pair like some members of the Cichlid family. A large tank is required, well planted with *Anacharis*.

The average length is three inches, maximum six.

The habitat is the basin of the Amazon, and fishes of this genus are noted for a bad disposition, which unfits them for association with other species.

280. What are the colors and breeding habits of *Metynnis maculatus*?

The back is dark olivaceous, the sides lighter, reflecting a yellowish sheen and marked with numerous brown spots. A large black spot is located at the gill cover. The caudal lobes and lower edge of the anal are dusky.

Breeding occurs at a temperature of 82°.

The average length is two and one-quarter inches, maximum six. The record of survival in captivity is 11 years.

The habitat is the basin of the Amazon, the disposition bad.

281. How is *M. maculatus* distinguished from *M. roosevelti*?

The bodies of these two species are somewhat similar but the colors of *M. maculatus* are more vivid and the spots more numerous.

282. What are the natural and artificial foods of the Hatchet Fishes?

They eat small animals such as crustaceans, insects and insect larvæ.

In the aquarium, they will take most dried, floating foods, but like also *Daphnia*, brine shrimps and similar live foods.

283. What water temperature do the Hatchet Fishes require?

72° to 75° generally. They have not yet spawned in captivity.

284. What is the habitat of the Hatchet Fishes?

Carnegiella and *Pterodiscus* are collected in the basin of the Amazon, *C. marthæ* lives also in the Orinoco River, and *C. strigata* and *P. levis* are found also in Guiana.

285. What are the colors of the Hatchet Fish, *Carnegiella marthæ*?

The body has a beautiful silver luster, the back being a little darker. The upper margin of the lateral line is edged with deep

orange. The belly is edged with black, and the pectoral fins are marked with black. The other fins are colorless. There is no adipose fin. The pectoral fins are large, like birds' wings in shape and in the manner in which they are carried, and the body is triangular, a most unusual combination. Viewed from the front, the little fish, with fins held high above its head, reminds one of a baby sea turtle trying out its flippers, and like baby sea turtles it has a gentle disposition. The name Hatchet derives from the sharply compressed body, with head wider than knifelike belly. It presents a triangular appearance from the front like the front of a hatchet.

This species attains a length of nearly one and one-quarter inches.

286. What are the colors and breeding habits of the Marbled Hatchet Fish, *Carnegiella strigata*?

The back is a rich olive brown and a dark lateral stripe edged with orange extends from the gills to the base of the caudal fin.



Photograph by Carl Rabl

The Marbled Hatchet Fish

The maximum length is one and three-quarter inches. The back is rich olive brown, and a dark stripe edged with orange extends from the gills to the tail.

Three irregular brown stripes run almost parallel with the anal fin and other wavy brown lines cross, forming irregular marbled markings. The spaces between these stripes are silvery. The ventral fins are small, adipose lacking. The female is broader bodied than the male.

This species attains a length of one and three-quarter inches. It is considered the most attractive of the Hatchet Fishes, probably because it is the most colorful. It is fairly robust and like the other Hatchet Fishes possesses an even disposition.

The transparent eggs are scattered among floating plants.

287. What are the colors of the Levis Hatchet Fish, *Pterodiscus levis*, formerly called *Gasteropelecus sternacula*?

The body is silvery, reflecting a bluish green luster. The ridge of the back is a light olivaceous color, and an indistinct stripe extends almost from the gills to the base of the caudal. A dark spot is located at the base of the dorsal, and all the fins are colorless. An adipose fin is present and the pectorals, as in other Hatchet Fishes, are winglike.

The average length of this species is nearly two and one-half inches.

SWORDTAIL CHARACIN, PENCIL FISH, DRAGON FIN, AND OTHERS

(FAMILY CHARACINIDÆ)

288. What is the habitat of the Small Round-mouth Characin, *Anostomus anostomus*?

It is found in British Guiana.

What are the colors and breeding habits of the Small Round-mouth Characin?

The back is dark fish green, and the sides are marked with three horizontal bands. One of these extends from the nose to the base of the caudal. This band is edged above with orange which reflects a metallic yellowish luster and below with a golden stripe. The dorsal, anal and caudal fins are marked with red. The average length is nearly three inches.

This species was introduced in 1933 and no data are available but the breeding habits are believed to be the same as those of *Nanostomus anostomus*.

The water temperature should be 75° generally, and raised to 82° if spawning is attempted.

Unlike some of the *Pæcilibrycons*, which swim in reverse fashion, this odd fish swims with its head down, belly up, at an angle of 45°. It has a long, snoutlike mouth, slender body and the adipose fin which characterizes the Characin family.

Ano means upward, *stomus*, mouth—an upward (or upward turning) mouth.

290. What is the habitat of the Swordtail Characin or Paddle-Fin Characin, *Corynopoma riisii*?

The island of Trinidad, where it is called the Swallowtail Sardinie. It was first described in 1858 by Dr. Theodore Gill, who gave it no less than three generic and four specific names.

291. What are the colors and breeding habits of the Swordtail Characin?

The body is silvery. A dark golden stripe runs from the gill cover to the caudal base, where it broadens and gradually fades completely. The male's dorsal and anal fins are large and rounded and the lower lobe of the caudal is prolonged. The female's fins are smaller and lack the paddlelike filaments which extend from the gill covers of the male almost to his caudal peduncle, and terminate in a scale about one-eighth inch in diameter. The adipose fin is lacking in this species.

The average length is one and one-half inches.

The eggs are deposited on plants, also in small clusters and rows on the under side of leaves. They hatch in from 24 to 36 hours and may number from 50 to 150 at a single spawning. The parents should be removed as soon as the eggs are seen. *Anacharis*, *Sagittaria* and *Cryptocoryne* are desirable plants for spawning this species. The male is not present while the female is depositing her eggs, a few at a time, on some selected plant, the leaves of which she has carefully cleaned in advance. It is said that she fertilizes them herself after placing them in the spot selected, with the sperm of the male, which she carries in her mouth. The female guards the eggs, moving them from one place to another, and refusing food during the period of their incubation. Sometimes the parents will eat the eggs, however.

The water temperature should be 72° generally, 80° for spawning.

This species is quite robust, peaceable, and very attractive for

the community tank. Mr. Guppy lists it as one of the important mosquito destroyers of Trinidad. It has survived for more than one and one-half years in captivity.

292. What is the habitat of the Red-spotted Copeina, *Copeina guttata*?

It is found in central Brazil.

293. What are the colors and breeding habits of the Red-spotted Copeina?

The back is dark olivaceous, the sides lighter with a bluish iridescent luster. The belly is grayish silver. Each scale bears a brilliant red spot. The fins are yellowish and a black spot on the dorsal fin is more distinct in the female. No adipose fin is present. The maximum length is nearly four inches.

A tank of at least 10 gallons' capacity should be used. A larger one is better. If the tank contains a flat stone this may be selected for the eggs, and the male, with the female's aid, will clean its surface in preparation for the spawn. Sometimes a shallow depression is cleared in the sand or gravel near the plants, and the eggs—500 to 1,000—are dropped there. The male will fan and guard them and also watch over the fry, which hatch in about 48 hours. The female should be removed as soon as spawning is concluded, and the male when the young are a few days old.

The water temperature should be 72° generally, 78° for spawning.

Unlike most of the Characins, this species' habits of propagation are similar to those of the Cichlid family. It is not recommended for the "happy family" tank or with smaller fishes, but gets on with fishes of its own size.

In its home waters it is important as a mosquito exterminator.

294. What is the habitat of the Threadlike Fish, *Copeina zepoldi* (formerly *Pyrrhulina filamentosa*)?

It lives in the basin of the Amazon, and is abundant in all brooks in British Guiana.

295. What are the breeding habits of the Threadlike Fish?

The breeding habits are very interesting. In native waters the female deposits her ova on a leaf two inches or more above the surface of the water. Both sexes leap together above the surface to the spot where the eggs are to be deposited and adhere there for a short

period while egg laying and fertilization are in progress. The eggs are extruded 10 or 15 at a time until from 80 to 100 have been produced, and appear to be encased in a gelatinous covering. The male keeps them moist by splashing water over them with his tail every 15 minutes or so. Fortunately they hatch in two or three days or his exertions might become irksome. The young drop down into the water and the parents take no further care of them and should be removed. In the aquarium the eggs sometimes are attached to the glass an inch above the water.

This species reaches a maximum length of four and one-half inches.

The temperature should be 72° generally, 80° for spawning.

296. What is the habitat of the Pigmy *Pyrhulina* or Rachow's *Pyrhulina* (*Pyrhulina rachoviana*)?

Argentina.

297. What are the colors and breeding habits of Rachow's *Pyrhulina*?

The back is olive brown, the sides lighter and the ventral region grayish silver. A dark brown, almost black, irregular stripe extends from the mouth to the base of the caudal fin. The fins are a light greenish yellow, the anal tipped with orange. A black oval spot surrounded with white is present in the dorsal fin. The edge of the caudal fin is metallic blue. During the breeding season the male develops a bright red border on pectoral and anal fins. All his fins are larger and more pointed than those of the female, and the upper lobe of the caudal, which in both sexes is longer than the lower lobe, is much more pronounced than in the female. No adipose fin is present.

The average length is one and three-quarter inches, the Pigmy *Pyrhulina* being the smallest member of this group.

From 100 to 200 transparent yellowish eggs are produced at one spawning. They are deposited on broad leaved plants such as Giant *Sagittaria* or *Cryptocoryne*. The male guards the eggs and aerates them by fanning them with his fins until they hatch—in 24 to 36 hours. The female should be removed as soon as the eggs are observed, and the male when the young hatch. If the parents are allowed to remain in the tank, surface plants should be provided in which the youngsters may hide. Some aquarists remove the leaf with the eggs to another tank and supply artificial aeration. A four gallon tank will be ample for breeding, though one of eight or 10 gallons

capacity is better, especially when the young are raised in the same tank with the parents. Except for an appetite for fish fry, the adults are harmless.

The water temperature should be 70° generally, 77° for spawning.

This little fish is good-natured, hardy, and will accept any food offered.

298. What is the habitat of the Black-banded *Leporinus*, *Leporinus fasciatus*?

Several South American rivers yield this species, including the Amazon and the rivers which meet in the Río de la Plata.

299. What are the colors and breeding habits of the Black-banded *Leporinus*?

The body is yellowish, and in the adults 10, sometimes 11, broad black vertical bands meet both dorsally and ventrally. It is said that as the fishes grow larger the black bands divide and increase in number. An adipose fin is present. The body is long and cylindrical, the mouth large, the snout pointed. The average length is four inches, maximum 12.

The species is under observation, with no definite data on breeding habits. It is said to deposit its eggs among the roots of plants.

The water temperature should be 75° generally and raised to 80° if spawning is attempted.

This genus has aroused much interest because of a peculiar habit of assuming an almost vertical position while swimming, with heads down. They are hardy fishes, peaceable by nature. Any food offered seems to be acceptable, though they are naturally herbivorous.

Another species now available, which closely resembles *fasciatus* except that it has more vertical bands, is *Leporinus affinis*.

Fishes of the genus *Characidium* are near relatives of Characins, of the genus *Leporinus*. They deposit their eggs among the roots of floating plants, such as Water Hyacinths and *Riccia*.

o. What are the characteristics of fishes of the genus *Nannostomus*?

They are peaceable by nature, graceful and sturdy. The small mouth makes fine food necessary, otherwise they are easy to care for and ideal for the "happy family" tank.

301. What foods will fishes of the genus *Nannostomus* accept?

Most prepared foods, scraped meat, shellfish, small live brine shrimps, *Daphnia* and other small live foods are taken.

302. What is the habitat of *Nannostomus aripirangensis*?

The lower Amazon.

303. What are the colors of *N. aripirangensis*?

The back is brown and the ventral region silvery white. One wide black band, extending from the mouth to the base of the caudal, is edged above with a narrow golden line, and above this golden line runs a red line. A more distinct red line is present in the ventral region, extending from the pectoral fins into the anal fin. There is a red spot at the base of the dorsal, also the caudal. The ventrals and anal are edged with light blue in both sexes. The sides and anal region show a lavender tint. The female is not so brightly colored. No adipose fin is present.

The breeding habits are the same as those of *N. anomalus*. The temperature of the water generally, and also for spawning, should be from 75° to 80°. (See No. 307.)

The average length is one and one-half inches.

304. What is the range of *Nannostomus marginatus*?

Northern South America, through British Guiana and in the Amazon River.

305. What are the colors and breeding habits of *N. marginatus*?

Three stripes, dark brown to black, extend from the head to the base of the caudal, one beginning above the eyes. The area between the first and second stripe is golden, that between the second and third is silvery. A fine red line runs just above and below the middle black band, this line being very distinct in the male, only occasionally present in the female. The golden stripes are less distinct in the female. The first rays of the dorsal fin are black, with a red spot behind them. The ventrals also show a red spot. The pectorals are transparent. This species possesses no adipose fin, has the broadest body, and yet is the smallest of the *Nannostomus* group. The maximum length is one and one-half inches.

We suggest that the tank be planted with *Riccia* for the eggs, which hatch in about three days at a temperature of 80°.

306. What is the habitat of *Nannostomus anomalus*?

The Amazon and Rio Negro Rivers.

307. What are the colors and breeding habits of *N. anomalus*?

Above, the fish is a light olive brown; below, a silvery white. A wide band of dark brown, almost black, extends from the mouth to the base of the caudal, terminating among the middle caudal rays. A golden line runs just above the band. The male has a reddish stripe above the base of the anal, this fin and the ventrals having bluish white tips, while the lower lobe of the caudal is red. All other fins are transparent. The base of the caudal, dorsal and anal is reddish and behind the gills and above the golden stripe runs a fine red line. This species lacks the adipose fin.

The eggs are small, almost transparent, and are deposited among rootlets and fine leaved plants. From 10 to 50 are laid at one spawning and hatch in about three days at a temperature of 80°. The fry cling to the plants and sides of the aquarium for five or six days and are not easy to raise because of their small mouths, for which only the finest foods such as infusorians and powdered prepared foods are suitable. They should be fed at least six times a day.

The average length of this species is about two inches.

The temperature of the water generally, and also for spawning, should be 75° to 85°.

308. What is the range of *Nannostomus trifasciatus*?

It ranges from the Rio Negro River of South America to the Basin of the Amazon.

309. What are the colors and breeding habits of *N. trifasciatus*?

The body is grayish brown, its ventral portion a light cream. Three dark brown stripes extend from the pointed nose to the base of the caudal fin, on which a carmine spot is conspicuous. The first rays of the dorsal are dusky. The dorsal, anal and ventral fins are spotted with carmine on a whitish background and their lower edges are light blue. The space between the first and second dark lateral stripes is golden orange and a thin reddish line runs above the second stripe. This red line is much more pronounced in the male. No adipose fin is present in this species. A length of nearly two inches is attained.

The tank should be well planted. *Myriophyllum*, *Cryptocoryne*, *Ludwigia*, and *Riccia* all may be used. The eggs are deposited, a few at a time, on the under side of broad leaved plants or among

surface plants. From 20 to 50 are laid during one spawning. It is customary to remove the parents as soon as the eggs are noticed, but some fanciers assert that they do not eat their young. The young hatch in about two days and may be seen hanging on the plants or sides of the aquarium. On the third day they become free swimming. Infusoria must be fed for from two to three weeks, also very fine powdered food, which should be given at least four times a day.

The temperature of the water generally should be 75°, raised to 85° for spawning.

310. What is the habitat of the Pencil Fish, *Poecilobrycon auratus*?

British Guiana.

311. What are the colors and breeding habits of the Pencil Fish?

Along the ridge of the back a fine black line may be seen. The back is light golden brown, the belly silvery white. There are three dark brown horizontal bands. The first extends from the nose to the upper caudal lobe. The second, which is wider, is made up of black spots and joins the first at the caudal base. The third band (a wide one) extends from the mouth into the lower caudal lobe, which is black. The lower edge of this band is made up of dots. The space between the second and third bands is golden and extends from the nose into the middle of the caudal base. The anal is brownish and shows a red spot. The outer edge of the male's anal is convex, while that of the female is straight.

Eggs are deposited on the under side of *Sagittaria* or *Cryptocoryne* leaves, and hatch in about 48 hours. It is advisable to remove the parents.

The temperature of the water generally should be 75°, raised to 82° for spawning.

A length of nearly two inches is attained.

This species swims in a slanting position, with the head up at the angle at which a pencil is held in the hand; hence the name. It is very peaceable and will eat almost any food offered.

312. What are the habitat and requirements of *Poecilobrycon unifasciatus* and *P. eques*?

They live in the Amazon Basin.

A temperature of 75° to 80° is suitable for them, and they will take both prepared and live foods.

313. What are the colors of *P. unifasciatus*?

The upper part of the body is dark brown, the belly silvery white. A black band extends from the nose into the lower caudal lobe, where it is dusky. Above and below this band near the caudal fin runs a red and white stripe. The body is long and slender. The female is not as large as the male, and the outer edge of her anal fin is straight while in his, which is slightly larger, the outer edge is convex. An adipose fin is present. The average length is two inches.

This species swims in a slanting position, head uppermost. It is quite peaceable.

314. What are the colors and breeding habits of *Poecilobrycon eques*?

The back is a light brown, the shoulder portion of a greenish tint. A reddish brown stripe extends from the mouth to the lower caudal lobe. Above and below this stripe the color is golden orange. The male's anal fin and the lower lobe of his caudal are reddish, while the colors of the female are somewhat lighter. An adipose fin is present. The average length is about two inches.

This species does not swim at an angle like some others of this group. It is a good-natured little fish.

The eggs, which are laid on the under side of *Cryptocoryne* or *Sagittaria* leaves, hatch in about 48 hours at a temperature of 80°. Parents should be removed after spawning.

315. What is the habitat of the Dragon Fin, *Pseudocorynopoma doriæ*?

It comes from Buenos Aires and Montevideo and is taken in the several South American rivers which find their outlet in the Rio de la Plata—an estuary lying between Uruguay and Argentina.

316. What are the colors and breeding habits of the Dragon Fin?

The back is a fish green, sides silvery with a bluish metallic sheen. A lateral line runs into the base of the caudal. The base of both dorsal and caudal fins is black. The upper part of the dorsal is reddish. The tips of the ventral fins and the lobes of the caudal are edged with black. The fins are transparent, showing a light greenish tint, and when viewed against the light the fish itself is almost transparent. The male's dorsal, ventral and anal fins are very

large, the fins of the female being less well developed. There is an adipose fin in this species.

It averages two and one-half inches, with a maximum of three.

A tank of at least 10 gallons' capacity should be provided, with a one inch layer of large pebbles and about eight inches of water.

The eggs are dropped in the same manner as those of the Zebra Danio (No. 368) and hatch in about two days at a temperature of 78°. The fry should be fed with infusoria or very fine prepared food at least four times a day for three weeks and later with small live foods—newly hatched brine shrimps, *Daphnia* and the like.

The adults take prepared foods, but prefer live foods.

THE KNIFE FISHES

(FAMILY NOTOPTERIDÆ)

317. What is the habitat of the Knife Fishes?

The African Knife Fish (*Xenomystus nigri*) is found only in Africa, but the Wingback Knife Fish (*Notopterus notopterus*) has a wider range through the East Indies, Malay Peninsula and India.

318. What are the colors and habits of the Knife Fishes?

The ground color is plain fish green or brown, touched with silver. The rippling anal fin is confluent with the caudal, giving the fishes at first glance an upside down appearance. Each has barbels on the upper lip. *Xenomystus* means strange upper lip and *Notopterus* means wingback, the latter species having a short dorsal though it does not resemble a wing. *Xenomystus* lacks the dorsal fin.

These fishes are pugnacious and suitable for the aquarium only when small, the Wingback attaining a length of over one foot and the African reaching eight inches. They prefer a live fish diet, but will take earthworms and strips of beef.

(FAMILY GYMNOTIDÆ)

319. What is the habitat of the Knife Fish, *Gymnotus carapo*?

This species is native to the West Indies, and also ranges south from Venezuela to northern Brazil.

320. What are the colors of the Knife Fish, *G. carapo*?

The body is brownish to fish green and banded perpendicularly with chrome. The anal fin resembles that of the other Knife Fishes, having about 180 rays.

The habits and disposition are the same as those of the other Knife Fishes.

321. What is the habitat of the Ghost Fish or Black Knife Fish (*Stenarchus albifrons*)?

Brazil is the home of this species, which is said to be held in awe by the natives as the abode of a spirit, hence the name of Ghost Fish. *Albifrons* means white front or white forehead, but the few specimens thus far seen in the United States were black fronted and black headed.

322. What are the characteristics of the Ghost Fish?

It can swim backward or forward, also perpendicularly up or down, and spends much of its time resting upright on its tail among the vegetation.

323. How is the Ghost Fish distinguished from the other Knife Fishes?

Though the dorsal fin is absent as in most other Knife Fishes, the long, wavy anal fin is not confluent with the caudal in the Ghost Fish. It is jet black with two tail bands of white, that nearer the end being the narrower. Also, it has a white dotted horizontal line anteriorly. The body is not compressed like that of the African Knife Fish. The Ghost Fish has no barbels, and the average length is four inches.

BARBS, FLYING BARBS, *RASBORAS*, DANIOS AND OTHERS

(FAMILY CYPRINIDÆ)

324. What are Barbs?

To the great family of the Cyprinidæ the Barbs or Barbels contribute several dozen species, mostly of small size, characterized, as a rule, by very large scales and the presence of barbels (soft, filiform, tactile appendages around the jaws). They are handsome, active and hardy fishes, but not all are even-tempered. About 10 of the smaller species commonly are available.

All are egg layers except *Barbus vivipara* from Natal, which, as its name indicates, brings forth its young alive.

One species, *B. mosal*, common in the mountainous regions of Asia, attains a length of from four to six feet and develops scales as large as those of the Tarpon—the size of the palm of one's hand.

325. What are the breeding habits of the Barbs?

They are careless and indifferent breeders, scattering their adhesive ova among the vegetation and not recognizing them except as objects of gustatory interest.

When the breeding season approaches and the water temperature is around 75° to 80°, the male begins to chase the female, and at short intervals, as she drops the eggs, he fertilizes them. They are a transparent light yellow, about the size of a pin-head. In the right light they can be seen adhering to the plants.

A tank of from five to 12 gallons' capacity is required, according to the number of eggs laid.

326. What foods do the Barbs require?

Prepared foods are readily taken, but chopped clams and mussels, ground beef, brine shrimps, *Daphnia*, white worms, fresh-water shrimps and tender plants are especially relished. The "fuzzy" plants should be provided as food for them. *Anacharis* is a favorite with the Dwarf Barb and others.

327. Which plants are best for spawning the Barbs?

Myriophyllum, *Cabomba*, *Anacharis*, *Nitella*, *Fontinalis*, and for some species the roots of water hyacinths.

328. What is the habitat of the Rosy Barb, *Barbus conchonius*?

British India is the home of the Rosy Barb, and it was introduced into England at the beginning of the 20th century.

329. What are the colors and breeding habits of the Rosy Barb?

The back is green with an orange tint, lighter on the sides, and the large silvery scales glisten like jewels as they reflect the light. The beautiful rosy tinge of the male is intensified during the breeding season. The fins are yellowish and the dorsal is edged with black. The female is not so brilliant, her fins being quite colorless. This species lacks the barbels characteristic of the genus.

The length is from two and one-half to three inches.

Rosy Barbs breed from early spring on through the summer. They begin to breed when five months old and require a large tank (10 to 15 gallons' capacity) as the eggs may number from 150 to more than 600, and like Goldfish fry, the young prey upon one another. The ova are scattered about among the vegetation and the adults should be transferred to another tank as soon as these are

observed. The fry hatch in from 36 to 40 hours, and hang on the plants and sides of the aquarium for the first two days, taking the horizontal position about the third day when they become free swimming. When they begin to move away from their anchorage, infusoria and fine prepared foods should be provided. In about one month they are ready for adult foods. They mature in from four to six months.

This species can exist in water 65°, but for breeding, the temperature should be from 70° to 75°.

The Rosy Barb is strong and playful, getting along well with fishes of its own size, but inclined to be quarrelsome when with smaller species and in small tanks.

330. What is the habitat of the Iridescent Barb, *Barbus oligolepis*?

Sumatra.

331. What are the colors and breeding habits of the Iridescent Barb?

The body color is a reddish brown, the back olivaceous, and the scales are spotted with dark blue, their edges opalescent. The fins are red or reddish brown and both dorsal and anal are edged with black. The female is not so brightly colored, with numerous dark spots on the sides. Her fins are almost colorless. One pair of barbels is present. A length of nearly two inches is reached.

The breeding habits are similar to those of the Rosy Barb. A five gallon tank is large enough as only 50 to 125 eggs are laid. They hatch in from 48 to 60 hours, the longer period when the water is cooler. (See No. 329.)

A temperature of 75° is required for this species generally, 80° for spawning.

This is a docile and pleasing little fish, recommended for the "happy family" tank.

332. What is the habitat of the Striped Barb, *Barbus lateristriga*?

India.

333. What are the colors and breeding habits of the Striped Barb?

The body is a light golden color with three broad greenish black bands on the side. One of these extends from the base of the first ray of the dorsal fin to the ventral fins. A horizontal band extends from

this band to the base of the caudal, and a vertical one lies between the gill covers and the dorsal fin. Two pairs of barbels are present. Most aquarium specimens are three or four inches long, but in a wild state this species attains to six inches.

The temperature of the water should be 75° generally, raised to 80° for spawning.

The Striped Barb is harmless to fishes of its own size, but not a good species for a "happy family" tank.

334. What is the habitat of the Banded Barb, *Barbus vittatus*?

Ceylon and southern India are its home.

335. What are the colors and breeding habits of the Banded Barb?

The body is light fish green, overlaid with silver. The middle portion is blotched with dark markings. All the fins are yellowish except the dorsal, which bears a golden brown spot at its base and a black vertical stripe edged with deep orange. A black oval spot on the caudal peduncle also is edged with orange. This species is



Photograph by Dr. E. Bade

The Banded Barb (*Barbus vittatus*)

This Barb, from Ceylon and southern India, exhibits the large eye, well-shaped fins and enormous scales which characterize the group, though it has no barbels. It is a docile species, well-behaved in the community tank.

without barbels. The sexes are difficult to distinguish but during the breeding season the abdomen of the female becomes deeper and the male's colors grow more vivid.

A length of two inches is attained.

The breeding habits are similar to those of the Rosy Barb, 50 to 250 eggs being laid. An aquarium of about five gallons' capacity is sufficient.

A water temperature of 74° should be maintained generally, 78° for spawning.

This is a docile species, well-behaved in the community tank.

336. What is the habitat of the Golden or Half-banded Barb, *Barbus semifasciolatus*?

China.

337. What are the colors and breeding habits of the Golden Barb?

The color is gray green to yellow, with seven irregular black bars over the upper half of the body. A golden lateral line extends from the gills to the caudal peduncle. The large silvery scales are edged with black. All the fins are golden or rosy in color. The female is not so colorful and her body is deeper. During the breeding season the belly of the male becomes flushed with red. This species has one pair of barbels.

A length of about three inches is attained.

The breeding habits are similar to those of the Rosy Barb. The eggs number from 150 to 400 or more, depending on the size of the female, and hatch in 36 to 40 hours. A 12 gallon tank is best for breeding this species.

The water temperature should be 74° generally, 80° for spawning.

This is a docile fish, desirable for the community tank.

338. What is the range of *Barbus ticto*?

It lives in the island of Ceylon and ranges also through southern India.

339. What are the colors and breeding habits of *B. ticto*?

The body is burnished silver, with a black spot just above the gill covers. A larger spot above the anal fin has a golden edge. The fins have a yellowish tint and the dorsal of the male is rosy and

The breeding habits are the same as those of the Rosy Barb, a water temperature of 80° being required, though generally 75° is warm enough, i. e., when not breeding. This species has a good disposition. (See Rosy Barb, No. 329.)

348. How is *B. stoliczkanus* distinguished from *B. ticto* and *B. conchoni*?

The orange-bordered spot near the caudal is more richly colored in this species than in *B. ticto*, which it resembles during the early stages. It is a little shorter and the black spots on its body are larger and more vivid than those of *B. ticto*. The dorsal fin of *B. conchoni* is tipped with black and has dark markings, and the dark spot on the body has a golden edge.

349. What is the habitat of the Three Spotted Barb, *Barbus trispilos*?

Liberia.

350. What are the colors and breeding habits of the Three Spotted Barb?

The color is golden straw and the scales reflect a silvery sheen. Three black spots on the sides are equally spaced. One is just behind the gill covers, the second at the center of the body, and the third at the caudal peduncle. The fins are light yellow, and there are two pairs of barbels. The body form is like that of the Rosy Barb, except that it is slimmer. It attains a length of two inches.

This is a new species and has not yet been bred. Propagation probably is like that of the Rosy Barb. The species is not very abundant. It appears to be hardy and peaceable.

A water temperature of from 75° to 80° is desirable.

351. Do "Flying Barbs" fly?

Those with which Mr. Lanier has worked never attempted to leave the water, but some aquarists have seen them skim over the surface for short distances.

352. What is the disposition of the Flying Barbs?

They are decidedly amiable and suitable for a "happy family" community.

353. What is the habitat of the Flying Barbs?

Esomus danricus comes from Ceylon and India, *E. malayensis* from the Malay Peninsula.

354. What are the colors and breeding habits of *Esomus danricus*?

The body is dark olive to brown, the belly silvery. A dark brown stripe runs from the mouth to the base of the caudal fin, where it meets a reddish spot. The pectoral fins are rose, all other fins light yellow. Viewed from above, the fish resembles a flying fish because of the winglike pectorals with their long filaments extending to the beginning of the anal fin. Both sexes are alike except that the female's body is rounder and deeper, and the male is not only slenderer but reddish posteriorly during the spawning season. Two pairs of barbels are present, the lower like long beards reaching to the ventral fins. Adults are said to lose the barbels as they grow older.

A length of nearly four inches is attained.

The eggs number from 75 to 250, for which a tank of 12 to 15 gallons' capacity should be provided, well stocked with *Myriophyllum*, *Nitella* and *Cabomba*, with a mat of *Fontinalis* at the bottom. The adults are spawn eaters and must be removed to save the progeny, which emerge from the eggs in two or three days.

The temperature of the water generally should be 75°, raised to 80° for spawning.

This little fish likes insects, crustaceans and white worms, but will take also scraped beef, and has survived on this fare for two years.

355. What are the colors and habits of *E. malayensis*?

The back is olive green, the sides lighter green, the gill covers golden yellow. A sheen, light pink to bluish, covers the sides. One black spot lies above the anal, another on the caudal base. Males are slenderer.

This species is not very abundant, but prospers under the same care recommended for *E. danricus*. Its breeding habits are similar, but it is a smaller fish, the maximum length being about three inches.

356. What is the habitat of *Rasbora heteromorpha*?

The Malay Peninsula and the island of Singapore.

357. What are the colors and breeding habits of *R. heteromorpha*?

The body is a rich red, suffused with light blue. The posterior portion is covered with a blue black triangle, the apex of which is at the caudal base. It extends close to both dorsal and ventral fins. All the fins are light pink except the dorsal and caudal, which are red with light margins. The length is about one and one-half inches. In the male the upper edge of the blue triangle is brighter, almost orange, and this is apparently the only mark of sex distinction in this species.



Courtesy John G. Shedd Aquarium

The *Rasbora* (*R. heteromorpha*) comes from Singapore and the Malay Peninsula and is strikingly colored but difficult to propagate.

Only three people in the United States and one or two in Germany have succeeded in breeding this fish. Mr. Lanier's *Rasbora* spawned twice in a 10 gallon tank planted with *Cryptocoryne* and *Ludwigia*. During the first spawning, 14 clear amber eggs were deposited on the under side of a large leaf of the *Cryptocoryne*. Three weeks later 22 more were deposited on the same plant. Apparently they were not fertilized in either instance, because they turned white on the second day.

Water temperature should be 75° generally, 80° for spawning.

The disposition of this species is mild, and it has survived for more than six years in captivity.

Live foods are liked, but prepared foods also are acceptable.

358. What is the habitat of the Spotted *Rasbora*, *Rasbora maculata*?

It lives in the swamps and ditches of India.

359. What are the colors and breeding habits of the Spotted *Rasbora*?

The body is a light olive with a reddish purple sheen. Three bluish spots adorn the sides, one behind the gill covers, another at the base of the anal fin, and the third at the base of the tail fin. The fins are spotted with red, orange and brown, the colors of the male being brighter. The body form is similar to that of the male Guppy, except that the fins are larger. This is the smallest of the known *Rasboras* and is not very abundant. Its average length is about one inch.

The eggs are deposited on the under surface of leaves in the same manner as are those of *R. heteromorpha*.

A water temperature of 75° is desirable, 80° for spawning.

Live foods are liked, but prepared foods also are acceptable.

360. What is the habitat of the Elegant *Rasbora*, *Rasbora elegans*?

The Malay Peninsula and Malay Archipelago. It exists in large numbers in the small streams of Singapore, Malacca, Sumatra and Borneo.

361. What are the colors and breeding habits of *Rasbora elegans*?

The body is light yellow to olive, and in a strong light reflects a purplish sheen. The fins are light orange and the tips of the caudal are dark. The anal fin of the male is yellowish, that of the female, clear.

R. elegans is distinguished from other *Rasboras* by a large black rectangular spot at the center of the body, a smaller black spot at the base of the tail, and a black stripe which runs parallel with the base of the fin.

The male averages three and one-half inches with a maximum of five, the female four and one-half inches with a maximum of nearly six. This is the largest of the *Rasboras* available for the home aquarium.

This species spawns on fine leaved plants, a water temperature of 75° generally and 80° for spawning being desirable.

The natural food consists of crustacea and vegetation, and in captivity any food offered is accepted. This species will survive over four years in the aquarium. It is good-natured like the other *Rasboras*.

362. What is the habitat of the Striped *Rasbora*, *Rasbora tæniata*?

It is indigenous to India.

363. What are the colors and breeding habits of *Rasbora tæniata*?

The body is fish green, reflecting a greenish blue sheen. The fins are light amber and the base of the caudal in the male is yellowish, while in the female it is much lighter. A narrow black line margined above with gold extends from gill cover to tail. The female has a much deeper belly, especially during the breeding season. The average length is about two inches.

The eggs are deposited among fine leaved plants and the tank should be well stocked with *Myriophyllum* and *Cabomba*. This *Rasbora* is not difficult to propagate.

A water temperature of 72° generally and 80° for spawning is desirable.

This is an amiable and fairly hardy species.

The natural foods are small crustacea, worms and insects. In captivity all prepared foods are accepted and shellfish and scraped beef are liked.

This species will survive from two to three years in the aquarium.

364. What is the habitat of *Rasbora daniconia*?

India and Ceylon.

365. What are the colors and breeding habits of *Rasbora daniconia*?

The upper part of the body is a medium olive color with a greenish sheen, the belly light grayish silver. A bluish black stripe on the side extends from the mouth through the eye to the middle of the caudal fin. The caudal sometimes is spotted with black and all the fins are yellowish. The sexes are not easily distinguished except during the breeding season when the female becomes distended with roe. The average length is three inches, maximum four.

The breeding habits are the same as those of *R. tæniata*.

This is a very peaceable, hardy species, which will survive for three or four years in captivity.

Most prepared foods are acceptable, but shellfish, white worms, *Daphnia* and brine shrimps are appreciated also.

366. How is *R. daniconia* distinguished from *R. tæniata*?

The lateral stripe of *R. daniconia*, which extends from the snout to the middle of the caudal, extends only from the gill cover to the tail in *R. tæniata*, which is also a smaller species.

367. What is the habitat of the Zebra Fish or Zebra Danio, *Brachydanio rerio*?

In East India it ranges through Bengal and Madras and is found also in Ceylon.

The name of Zebra Fish derives from its yellow stripes.

368. What are the colors and breeding habits of the Zebra Danio?

The back is fish green, the sides, also anal and caudal fins, bluish. Through this color run stripes of straw yellow from the gill covers to the caudal fin. Similar stripes are present also in the anal fin. The pectoral and dorsal fins are a light greenish yellow, and the dorsal has a dark tip. There is one pair of hairlike barbels. When mature, the male is a trifle smaller and slenderer than the female. His colors are brighter and his anal fin is brownish yellow, while hers is yellowish.

The average length of this species is one and one-half inches, the maximum, two.

One pair can be successfully spawned if they are in proper condition, but best results will be had if two males are used to one female. A tank at least 14 inches in length, six inches deep and eight inches wide, well planted in the center with *Nitella* or *Myriophyllum*, and with the bottom covered with pebbles or marbles, is necessary in order to save the spawn. During the period of spawning the fishes become exceedingly animated and the female drops from eight to a dozen eggs at intervals of about two minutes, until she has laid 150 to 350. These are transparent and if they lodge between the marbles or pebbles they are safe. The adults must be removed immediately after the conclusion of spawning, which will be evident from the much slimmer body of the female. The fry hatch in about two days and cling to the plants and sides of the aquarium for from 36 to 48 hours until their yolk sacs are nearly absorbed. Then they become free swimming and either at this time or sooner should be fed with infusoria.

The temperature of the water generally should be about 68°, but for spawning it should be raised to about 80°.

The Zebra *Danio* swims in schools, is very strong, active and graceful, also amiable, friendly and alert. It is a community breeder and a number of young have been raised to maturity from eggs deposited in a 25 gallon tank containing 50 to 75 adults. It has survived for three and one-half years in captivity.

Prepared food is suitable, and of course live food is actively hunted.

369. What is the habitat of the Spotted *Danio* or Dwarf *Danio*, *Brachydanio nigrofasciatus* (formerly *B. analipunctatus*)?

Lower Burma, British India.

370. What are the colors and breeding habits of the Spotted *Danio*?

The body color is light fish green, darker above. A pink band, edged above and below with dark blue, extends from the opercle to the caudal fin. Below this blue line are a number of black dots which extend into the lower fins. The ventral region is light yellow to tan. The colors of the male are deeper. He is also slenderer and his dorsal and anal fins are greenish yellow, which becomes darker toward the edges. The average length of this species is one and one-half inches.

The tank should be well planted with fine leaved vegetation such as *Myriophyllum* and *Nitella*, arranged in the same manner as for the Zebra *Danio*. The female deposits from six to a dozen eggs while balanced in an almost upright position among the plants and these, of course, are fertilized by the male. The adults should be removed as soon as spawning is over. Egg-binding occurs in this species, which is not as prolific as the Zebra *Danio* and is more difficult to propagate.

The water temperature should be about 80° for breeding, otherwise 70° is correct.

This is an attractive little fish, though not as brisk in its movements as the Zebra *Danio*. It will survive for three years in the aquarium.

It is fond of raw beef and live food, but will accept prepared foods also.

371. What is the habitat of the Pearl *Danio*, *Brachydanio albolineatus*?

The Dutch East Indies and Malay Peninsula claim this species.

372. What are the colors and spawning habits of the Pearl Danio?

The body is a light greenish blue suffused with pink and delicate lavender. The back is darker, the ventral region lighter. A light cerise stripe extends from the pectoral fins into the caudal fin. This stripe widens toward the rear and is darker at the caudal base. The dorsal, caudal and anal fins are a light olive green and the base of the anal is reddish orange.

The average length is two inches. •

The care and breeding habits are similar to those of the Zebra Danio. The male is usually slenderer than the female, particularly during the breeding season. The eggs hatch in from 36 to 48 hours, and the young develop rapidly. They have been bred when six months old.

The water temperature generally should be about 75°, raised to about 82° for breeding.

This is a sturdy, active species and decidedly peaceable. It likes scraped beef, but takes also prepared foods. It has survived for three years in the aquarium.

373. What is the habitat of the Giant Danio (*Danio malabaricus*)?

It is found along the Malabar Coast of India.

374. What are the colors and spawning habits of the Giant Danio?

The body is a metallic turquoise blue, the belly of a pinkish hue. Just behind the gill opening there are a number of golden vertical zigzag bars. Extending from these bars toward the caudal are three golden stripes which divide the blue into three bands, the central band terminating in the caudal fin. All the fins are colorless save the unpaired fins, which are pinkish at their base. The males are smaller and slighter and their colors more vivid.

The average length of this Giant is three and one-half inches, maximum four and one-half.

A large tank is necessary and plenty of plants must be supplied to catch the slightly adhesive eggs. The care and culture are similar to those of the Zebra Danio. The eggs hatch in from 36 to 60 hours. Their number varies from 100 to 300 according to the size of the female.

The water temperature generally should be 75°, 80° for spawning.

This *Danio* is robust, good-natured, active and colorful, will accept any food offered, and has survived in captivity for four years.

375. What is the habitat of the Japanese Bitterling (*Acheilognathus intermedius*)? *

This species, of a different genus from the Chinese and European bitterlings, is native to Japan.

376. What are the colors and habits of the Japanese Bitterling?

The color is silvery on the sides and fish green above, the belly creamy white to orange. The male's dorsal fin is dusky, his pectorals



Photograph by Robert J. Lanier

Japanese Bitterlings, male (right) and female (left).

orange, his ventrals a lighter orange, his anal orange edged with black. All the fins of the female are dusky and she has a deeper body.

The average length is from two to two and one-half inches.

Any food offered is taken, and the temperature, breeding habits and requirements are the same as for the European Bitterling. (See also European Bitterling, Nos. 688-690.)

* The Japanese Bitterling is not a tropical species, but is included in this chapter because it is commonly maintained in this country in community tanks with toy tropicals.

THE LOACHES

(FAMILY COBITIDAE)

377. What is the habitat of the Japanese Loach or Dojo (*Misgurnus anguillicaudata*)?

It is abundant in all the lakes and rivers of Japan, and is found also in China and Formosa. The specific name means eel tailed. The origin of the generic name, *Misgurnus*, is obscure.

378. What are the colors and requirements of the Dojo?

The color is subject to great variations, like that of other Loaches. In some specimens the lower part of the body is mottled with brown. A lateral line runs to the base of the caudal fin. The trunk is covered with small cycloid scales, that is, those with concentric rings and smooth edges, but the head is naked. The body is compressed, nostrils close together and in front of the eyes, and the thick, fleshy lips are offset with barbels, 10 in all, four of which are on the lower jaw.

This Loach averages six inches in length, with a maximum of over seven. It thrives in living-room temperature, 68° to 72°. We have no record of its having bred in captivity, but it will survive for upwards of five years.

It takes almost any kind of fish, shellfish or meat, and has a greedy appetite. It is a bottom feeder by nature.

It should be supplied with fine sand, which it enjoys taking in its mouth and squirting backward through its gills.

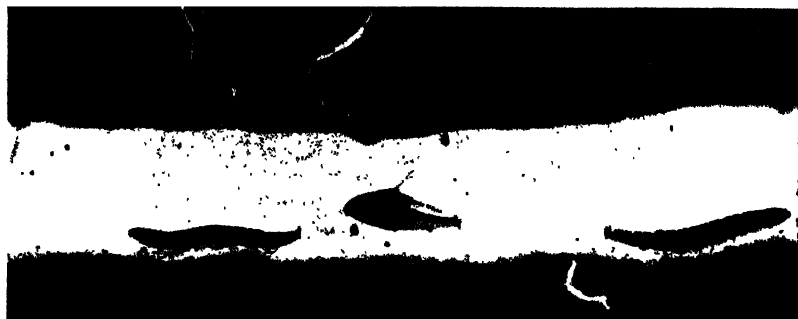
379. What is the habitat of the Malay Loach (*Acanthophtalmus kuhlii*)?

The Malay Peninsula and Dutch East Indies, where it lives in sluggish, muddy streams.

380. What are the colors and characteristics of the Malay Loach?

The little body (it reaches a length of not more than three inches) is beautifully marked. The sides are reddish orange, and 20 or more light brown irregular markings seem to circle the entire body, so that there is a regular alternation of orange and brown. Six maxillary barbels are present, two located at the tip of the snout.

Like other Loaches, this species is robust, good-natured, and an excellent scavenger. It takes any food offered.



Photograph by Robert J. Lanier

Scavengers—Dwarf Catfish (Center) and Malay Loach

Popular for the community tank are the Dwarf Catfishes (*Corydoras* of several species) and the Malay Loach (*Acanthopthalmus kuhlii*).

THE DWARF CATFISHES

(OF VARIOUS FAMILIES)

381. What is the habitat of the Dwarf Catfishes?

The majority of these "bewhiskered" little fishes, many brightly colored, are of South American origin. They are good-natured, sturdy and popular.

Those of the genera *Corydoras* and *Callichthys* belong to the family Callichthyidae, *Pimelodella gracilis* belongs in the family Pimelodidae, *Loricaria*, *Otocinclus* and *Hypostomus* are in the family Loricariidae or Mailed Catfishes, and *Kryptopterus* is in the family Siluridae.

Others not frequently obtainable are the *Acanthodoras* and *Astrodoras* of the family Doradidae, each having six barbels.

382. What are the characteristics of the Dwarf Cats of the genus *Corydoras*?

New species of Catfishes of this genus are constantly sought by the aquarist, and seldom, if ever, prove disappointing in the community tank. So many are collected in Brazil that the majority are known as Brazilian Catfishes, though called also by the generic name of *Corydoras*.

They seldom exceed three inches in length, the body is "armored," i. e., covered with bony plates instead of scales, the adi-

pose fin is conspicuous. These fishes are prized as pretty scavengers. They are hardy, surviving for upwards of five years even in a community tank.

The sexes are distinguished by the smaller size of the male and his longer and more pointed dorsal and ventral fins.

The eye is bright, the mouth has four short barbels, and usually the fish green body and fins are generously mottled with black.

Living-room temperature—68° to 72°—generally is suitable, but should be raised to 80° for spawning.

The female attaches her eggs to the plants or glass of the aquarium, where they hatch in from eight to 10 days. If one is lucky he may rear as many as 100 young from one spawning.

383. What are the colors of the Dwarf Catfish, *Corydoras nattereri*?

The body color is light fish green or dull gold, darker on the back. A greenish gold stripe extends from the gill covers to the base of the caudal fin, and the gill covers reflect a greenish yellow sheen. The belly is creamy white or yellowish. The first ray, also the base of the dorsal fin, are dusky.

This hardy little Catfish from eastern Brazil reaches a length of two and one-half inches, and is one of the most popular scavengers for the community tank of toy tropicals.

Another similar but more active species, *C. hastatus*, is distinguished by a white crescent on the base of the caudal fin, at the edge of a black spot which lies at the end of a dark stripe running from the pectoral fins into the caudal.

384. What are the characteristics of the Graceful Cat (*Pimelodella gracilis*)?

This Catfish is a lithe, graceful creature, with fish green or chrome tinted sides banded with dark lateral stripes. The head is large and there are three pairs of long barbels, also an adipose fin.

The maximum length is six inches.

Its habitat is from Brazil southward. Other Cats of this genus are native to Trinidad.

385. What are the characteristics of the genus *Loricaria*?

These Cats are called "sucker mouths" because they can attach themselves to stones or glass by their large mouths.

L. parva has a fusiform body very much attenuated at the caudal

peduncle, and the upper and lower rays of the tail are prolonged in threadlike filaments. *Loricaria* lack an adipose fin.

This genus is found in Paraguay.

386. What are the characteristics of the genus *Otocinclus*?

These Armored Cats with sucker mouths are fusiform, but have stouter bodies than the genus *Loricaria*. They are laterally striped with black and the maximum length is three inches.

Fishes of this genus are indigenous to Brazil.

387. What are some facts about the Sucker Mouth Cat, *Hypostomus plectostomus*?

This species, suitable for the home aquarium only when small (the maximum length being 16 inches), ranges along both slopes of Panama and south to Uruguay. It was described by Linnæus in 1776, but did not reach North American aquariums until recent years.

The color is brownish green with irregular dark marks, the fins are large and the barbels extremely long. This Catfish is notable chiefly for its habit of clinging by the mouth to stones and the sides of the aquarium.

388. What is the habitat of the Glass Catfish or Ghost Fish, *Kryptopterus bicirrhus*?

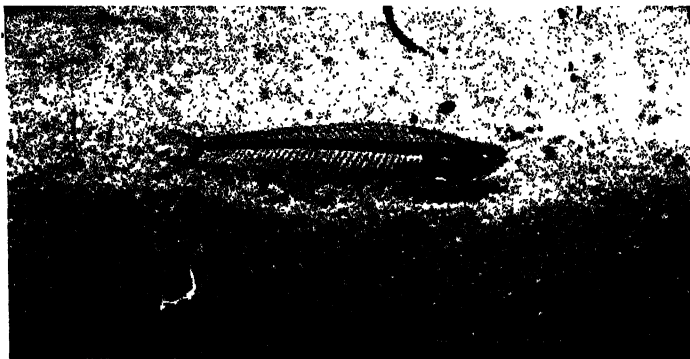
It is found in the fresh waters of Java, Borneo, Siam and Sumatra.

389. What are the colors of the Glass Catfish?

The body is thin, silvery and transparent, yet reflects all the colors of the rainbow. Both the body and the long anal fin are so transparent that any object can be seen plainly through them. Two transparent barbels are present and may be three-fourths of an inch in length on a specimen only two and one-half inches long. A single, threadlike dorsal ray measures about one-quarter inch.

The maximum length is seven inches, the little fish is strong and amiable, likes live food such as white worms, *Daphnia* and brine shrimps, but will take small pieces of beef and even dried foods.

The Glass Catfish has a habit of placing itself midway in the tank or near the bottom, and waving its glassy body constantly, like a flag in the wind.



Photograph by Robert J. Lanier

The Glass Catfish or Ghost Fish

Both body and fins are so transparent that any object can be seen plainly through them.

(NEST BUILDING CATFISHES)

390. What is the habitat of the Armored Cat, *Callichthys callichthys*?

This species is a native of Brazil.

391. What are the colors and breeding habits of the Armored Cat?

The body is plain fish gray and is remarkable for the herring-bone effect produced by the many armored plates slanting backward from either side of the lateral line. Four barbels are present, two upper and two lower, the latter turned upward like horns. The fish also has a long adipose fin, which is supported by a spine.

It is a bubble-nest builder and both parents keep vigil over the eggs and young.

A temperature of 80° should be maintained during the spawning period.

The average length is three inches, the maximum seven.

BUTTERFLY FISH

(FAMILY PANTODONTIDÆ)

392. What are the range and habitat of the Butterfly Fish (*Pantodon buchholzi*)?

This unusual little "fish with wings" comes from West Africa.

393. What are the colors and breeding habits of the Butterfly Fish?

This species is not brilliantly colored, fish green and tan being the prevailing hues, though purple dots may appear on the body and fins. The large pectoral fins are winglike and used in skimming along the surface of the water in search of insect prey.

As in many other fishes, the sexes are distinguished by differences in the fins. In the male the anal fin is notched and his dorsal is pointed. In the female both these fins are rounded.

The maximum length is four inches.



Courtesy John G. Shedd Aquarium

The Butterfly Fish (*Pantodon buchholzi*) uses its winglike pectoral fins for skimming along the surface of the water in search of insect prey, and is one of the few fresh-water Flying Fishes known. It will breed in captivity.

Pelagic eggs are laid; which are not guarded by either parent and may be dipped out for hatching in another aquarium. Spawning has occurred frequently at temperatures ranging from 75° to 85°. The fry hatch in three days and absorb their yolk sacs within a week. They require infusoria, Daphnia, small brine shrimps, wax-worms, meal worms and similar live foods.

The Butterfly Fish spends its time at the surface of the water, preferably resting among the plants with the aid of the long, finger-like filaments of the ventral fins, and is one of the few fresh-water Flying Fishes known.

Except when breeding, living-room temperature is suitable, 68° to 72°.

The food consists of insects captured at the surface of the water.

In captivity it takes bits of fresh beef if dangled before it, but prefers live foods such as meal worms, small earthworms, wax-worms and flies. It eats only at the surface and no food will be taken which falls to the bottom, however hungry the fish or tempting the morsel.

The Butterfly Fish will survive two years or longer in captivity if it does not have a chance to jump out and dry up. A wire cover is suitable for the aquarium and it must not be left without a cover at any time.

RIVULUS, *PANAX*, MEDAKA, AFRICAN TOP MINNOWS,
CUPAN KILLIE AND FLORIDA KILLIES

(FAMILY CYPRINODONTIDÆ)

394. Which fishes are called *Rivulus*?

The members of this genus, called also "egg laying Killies," have a cylindrical body and rather small mouth, and their fins are evenly rounded with no elongations. The species commonly kept in North American aquariums are *R. tenuis* of southern Mexico, the Green *Rivulus*, *R. cylindraceus*, of Cuba, *R. urophthalmus* of South America, Trinidad and Tobago, *R. strigatus* of southern Brazil, and *R. xanthonotus* of the Amazon Basin.

The following species are not abundant and some are not available: *R. santensis* of Brazil, *R. ocellatus* of southern Brazil, *R. dorni* of Rio Janeiro, and others from Haiti, Costa Rica, Panama and Guatemala; also a closely related species, though of a different genus, *Rachovia brevis* from Colombia.

395. What is the disposition of the *Rivulus*?

All are good-natured, sturdy little fishes.

396. What food is necessary for *Rivulus*?

Prepared fish foods are accepted, though they prefer live food such as garden worms, white worms, *Daphnia* and brine shrimps.

397. What water temperature is required for *Rivulus*?

Between 74° and 80° is the correct temperature, except for the Green *Rivulus* (*R. cylindraceus*), which prefers a temperature of from 65° to 75°.

398. What size do *Rivulus* attain?

Two to two and one-half inches is the size of the *Rivulus*, except *R. xanthonotus*, which attains a length of three inches.

399. How are the sexes distinguished in *Rivulus*?

An ocellus or eye spot on the upper part of the caudal fin characterizes both sexes in *R. ocellatus*. The eye spot, which is faint in the male, is conspicuous in most females of this genus except *R. santensis*, in which it is indistinct, and in *R. strigatus* and *R. dorni*, in which it is absent.

400. What are the characteristics of *Rivulus*?

They lie for hours among the floating plants, with their bodies half out of the water, often leaping out and adhering by their tails to aquatic plants or the sides or cover of the aquarium, and remaining thus, entirely out of the water, for long periods.

401. What are the breeding habits and requirements of *Rivulus*?

An aquarium holding two gallons will serve. Floating plants such as *Riccia* and *Utricularia minor* are needed for catching the eggs. Others which are also used are *Anacharis*, *Vallisneria* and *Myriophyllum*. The eggs number 40 to 100 or more and hatch in from 12 to 14 days. When spawning is concluded, the adults should be removed to save eggs and fry. They are not difficult to rear and any novice who has raised Guppies will be able to raise most of the *Rivulus*.

402. How long will *Rivulus* live in captivity?

Three years or longer.

403. What are the range and habitat of the Leaping Fish, *Rivulus harti* (or *R. urophthalmus*)?

This is a very common species in the islands of Trinidad and Tobago, where it occurs at high elevations, and is found in South America in Venezuela, Granada and the Amazon Basin. Some individuals are partial to dirty little pools. Therefore, they like low or high temperatures, to correspond with the waters from which they are taken, mountain dwellers preferring water not above 65° while those from the Amazon and from small pools like it 80° or higher.

404. What are the colors of the Leaping Fish?

These vary greatly with age. Very young specimens have a distinct ocellus as a rule, while adults may have two ocelli, one, or none.

Some have green bodies with seven rows of longitudinal red spots, as if the sides were laid out in emerald chains bordered with garnets, set off by a head of electric blue; others are silver blue with black tails bearing white margins.

405. What are the characteristics of the Leaping Fish?

It is a solitary species, sometimes the only one occupying mountain streams and ponds. Its habit of traveling across country through the wet grass, by a series of quick leaps, has given it the name of Leaping Fish. Often it leaves the water and clings to the grass for a long time, adhering by means of its oval tail in any position, even head down. It will jump out of the aquarium if the top is left uncovered. It attacks its prey after the manner of a Barracuda (which is to say it is more voracious than a Shark). Mr. Guppy says the greed of this species is so great that several will fight in the water for the first place on the hook. (Bibliography No. 219.)

It must be kept by itself in the aquarium.

This species attains an average length of three inches, with a maximum of four.

406. What is the food of the Leaping Fish?

Even the very young are cannibals, and live food is the only menu that attracts this species. It swallows large Guppies whole and also finds larval mosquitoes toothsome.

407. What are the range and habitat of the Blue *Panchax* (*Panchax panchax*)?

This species is native to India, the Dutch East Indies and the Malay Archipelago, where it inhabits clear, shallow waters.

408. What are the colors and spawning habits of the Blue *Panchax*?

This *Panchax* varies greatly in coloration, often exhibiting a blue body ornamented with red-bordered, yellow fins; but the ground color may be green or light brown and the fins orange with blue margins. A large ocellus usually may be seen on the dorsal fin.

For breeding, a seven gallon tank is sufficient, well stocked with *Vallisneria*, *Anacharis*, *Sagittaria* or *Ludwigia*, or a combination of

any two of these, together with floating plants of such species as are available. The eggs are adhesive but not heavy, and attach to semi-submerged or surface vegetation. Incubation occupies about 14 days, as the eggs are not all deposited at once but laid at the rate of about 25 over a period of seven or eight days, the same program being repeated a few days later and the spawning period extending over 10 weeks or more. When 400 or more ova have been produced, it is customary to remove to other tanks the plants containing them. The fry hatch in about two weeks and require baby fish foods. (See No. 192.) This species matures when half grown, in about four months.

The average length is one and three-quarter inches, maximum four.

The temperature of the water generally should be 70°, 75° for spawning.

This is a strong and gentle little fish, easy to please, as it takes ready-to-hand foods. It likes minced fish and shellfish, enchytraids, wax-worms and bits of earthworm, also *Artemia*. In a state of nature it is largely insectivorous, but subsists also on fish fry and other small animals.

409. What is the habitat of the Dwarf *Panchax* (*Panchax blockii*, formerly *P. parvus*)?

This species is a native of India and called also the Madras *Panchax*.

410. What are the colors and spawning habits of the Dwarf *Panchax*?

The body of this mild-mannered little fish is a shining fish green, the belly violet blue. Each gill cover is ornamented with an emerald spot. The chin is streaked with red. The larger fins of the male are salmon, edged with orange red, and his sides appear to be lighted like those of a deep-sea luminous fish with horizontal rows of glowing rubies and emeralds. The female is not as vivid and her fins are rounded.

The average length is one and one-half inches, maximum two.

The spawning habits and foods are similar to those of the Blue *Panchax* (which see). A tank of five or six gallons' capacity is sufficient for this small species.

411. What is the habitat of the Lined *Panchax* (*Panchax lineatus*, formerly *Haplochilus rubrostigma*)?

India, in Madras and the vicinity of the Malabar Coast.

412. What are the colors and spawning habits of the Lined *Panchax*?

The body is dark fish green, with brownish back and belly. The sides of both sexes glitter with dots of Roman gold and are marked with wide vertical stripes, often more conspicuous in the female. A black spot on the dorsal fin also is more noticeable in the female. The large fins (i. e., all except the pectorals and ventrals) are green, streaked and bordered with rich red, though the color is not as vivid in the female.

Aquarium specimens not infrequently are four inches long, including the tail.

The foods and spawning habits are similar to those of the Blue *Panchax* (No. 408).

The temperature of the water generally and also for spawning should be 68° to 70°.

413. What is the habitat of the *chaperi* or Chaper's *Panchax* (*Epiplatys chaperi*, formerly *Panchax chaperi*)?

Africa.

414. What are the colors and spawning habits of the *chaperi*?

The body is brown, banded vertically with darker brown or black, and in the male the fins are orange yellow or leaf green. The chin is red.

The sexes are distinguished by the color of the lower jaw—green in the female, red in the male; also by the more rounded fins of the female.

The average length is two to two and one-half inches.

The foods and spawning habits resemble those of the Blue *Panchax*, which see. (No. 408.)

This is a good-natured fish, trustworthy with others.

415. What is the habitat of Playfair's *Panchax* (*Pachypanchax playfairii*)?

Zanzibar.

416. What are the colors and spawning habits of Playfair's *Panchax*?

The yellowish green body of the male is dotted with rubies, present also in the dorsal, caudal and anal fins. The plainer female bears a "thumb mark" on her dorsal.

The average length is two and one-half inches, maximum four.

The spawning habits and foods are similar to those of the Blue *Panchax*, but the eggs must be removed as speedily as possible.

The temperature of the water should be 72° generally, raised to 75° for spawning.

This *Panchax* has a quarrelsome nature.

417. What is the habitat of the Medaka (*Aplocheilichthys latipes*)?

In Japan it is found commonly in rice fields and ditches.*

418. What are the colors and breeding habits of the Medaka?

It has a silvery body dashed with gold, or a light orange body with silver abdomen. An orange gold variation acquired by artificial selection is called the Golden Medaka. In outdoor pools the Medaka often assumes a reddish color. The pectorals of the male are larger than the female's and are pointed. His caudal is square, while hers is rounded and her abdomen is deeper.

Curiously, in this species when the female extrudes her eggs they do not fall, but adhere to her body, where from 50 to 225 may be present in clusters like tiny bunches of grapes. There they are fertilized and then brushed off, one or more at a time, onto some suitable bit of vegetation, *Myriophyllum* and other "fuzzy" plants being favored for this purpose. If the temperature of the water is 74°, the eggs "eye," (i. e., the small black eyes of the young become visible) in six or seven days, and hatch in another week. If the temperature is 78°, the fry will be out of the eggs in 10 days. They eat infusoria and baby fish foods and in about six weeks are ready for larger fare—*Daphnia*, enchytræids and the like. The species is prolific and easily reared.

The ability of the Medaka to withstand rather cool water (50°) makes it a good garden pool fish. It will thrive and breed in living-room temperature (68° to 72°).

It is a sturdy, even-tempered little fish, which attains a maximum length of nearly two inches, and will take any food offered.

A similar fish, *Micropanchax* (or *Aplocheilichthys*) *schoelleri*, of Egypt, is colored green and blue, requires the same temperature, but does not carry the eggs.

419. Which fishes are called *Aphyosemion*?

The members of this genus, which constantly grows larger and now is divided into several subgenera, have cylindrical bodies and

* The Medaka is not a tropical species, but is included in this chapter because it is commonly maintained in this country in "happy family" tanks with toy tropicals.

upturned mouths like the *Rivulus*. The males are beautifully colored and except for *A. cameronense* (called the Zebra Carpet from Kame-run—a river in West Africa) and the Red or Gold Pheasant *Fundulus*, *A. sjoestedti*, have lyre-shaped tails. They are sturdy little fishes abounding in Central West Africa coastwise along the Gulf of Guinea, some ranging south of the Congo.

The species best known and commonly available are the Cam-eronensis or Cape Lopez *Haplochilus*, *A. australe* (formerly *Haplo-chilus cameronensis*); *A. calliurum* and its near relative the Blue *calliurum*, *A. calliurum ahli*, and in the *Fundulopanchax* division include the Blue Gularis, *A. caeruleum* (better known as *Fundulopanchax caeruleus* or, wrongly, *coeruleus*), and the Yellow Gularis, *A. gulare* (better known as *F. gularis*); also the Steel Blue *Fundulus* (*A. gardneri*) and the Banded *Fundulus* (*A. bivittatum*).

There are eight or 10 other species.

The maximum length is from two to three inches.

420. What is the disposition of the *Aphyosemion* group?

All are not good-natured, but Cameronensis is trustworthy in the "happy family" community.

421. What temperature do fishes of the *Aphyosemion* group require?

70° to 75°. Under correct conditions they will survive for upwards of three years in captivity. The entire group does well in alkaline water, and often has bred at pH 7.5.

422. What foods are necessary for the *Aphyosemion* group?

They prefer live foods such as insect larvæ, crustaceans and worms, brine shrimps and similar foods, but will take chopped meat, fish, and shellfish.

423. What are the breeding habits and requirements of the *Aphyosemion* group?

The majority breed at from six months on, and require shallow water with floating or semi-submerged vegetation for catching the eggs (*Riccia*, Bladderwort and the like). Parents are spawn-eaters and should be removed as soon as the eggs are noticed, or the plants to which the eggs have adhered may be transferred to another aquarium. These are large and laid one at a time. They hatch in from 10 days to two weeks at a temperature of about 75° and the young

take water fleas and later newly hatched *Artemia*, small wax-worms and enchytraëids.

Some fishes in the *Fundulopanchax* division of this group (see No. 419) drop their eggs on the bottom in the mulm, where they hatch in from five to seven weeks.

424. What are the colors of the Cameronensis (*Aphyosemion australe*)?

The males of this species, as of this entire genus, are very beautifully colored. Their lyre-shaped tails are submargined with red brown (which is matched by horizontal broken lines over head and body), and margined with yellow and white. The back is brownish, the sides and body robin's egg blue. The large dorsal and anal fins have pointed posterior tips and are green or fawn colored, with purple submargins, red margins, and lemon tipped edges. The fawn colored pectoral and ventral fins show submargins of orange, in the latter interbordered with brown.

425. Which fishes are called *Nothobranchius*?

The members of this genus, all from East Africa and not always available, are vigorous, full bodied, and have exquisite colors in which blue predominates.

They are partial to live foods but will take chopped meat, fish and shellfish.

The eggs are heavy and adhesive, and fuzzy plants are required for catching them (the same as in the case of Goldfishes which the males resemble in their habit of chasing the females). The fry are fed the same as Goldfish fry, but are not as easily reared.

426. What is the habitat of the Cuban Killie (*Cubanichthys cubensis*)?

This species was discovered in 1902 in the streams of Pinar del Rio, in western Cuba.

427. What are the colors and spawning habits of the Cuban Killie?

The sides are greenish or reddish brown, and a dark band runs from eye to tail, bordered above and below by a band of bright orange. Another dark band runs through the lower part of the eye forward, below the chin. The ventral and anal fins are not pigmented. There is a dark humeral (shoulder) spot just above the origin of the pectoral

fin. The tail is round and dotted evenly with several vertical rows of dark spots.

The length is about one and one-half inches.

To the ichthyologist this little Killie is interesting because of its double row of teeth and short intestine.

The temperature generally should be 70°, 75° for spawning. In a five gallon aquarium this Killie will spawn among the plants, the eggs hatching in less than two weeks.

428. What are the foods of the Cuban Killie?

The food is of an animal nature, as indicated by the teeth and short intestine. It consists principally of very small mollusks, crustaceans, and insects and their larvæ.

In the aquarium live food is favored, but chopped meat, fish and shellfish are accepted.

429. Name some Florida Killies.

Various species of beautifully patterned Killies which abound in Florida thrive and breed in southern aquaria and in heated aquaria in the north.

Among them are the American Flag Fish (*Jordanella floridae*), the Ocellated Killie (*Leptolucania pinnata*), Goode's Minnow (*Chriopeops goodei*), *Fundulus confluentus*—a species of the lakes and rivers, believed by some ichthyologists to be the same as *F. ocellaris*; *Zygonectes cingulatus*, which lives in ponds, lakes and rivers and also ranges northward to New Jersey; and the Seminole Killie (*Z. seminolis*) which is indifferent to the kind of water it inhabits, being equally happy in a creek, swamp, sulphur spring or river, and commonly found in all these places.

430. What are the range and habitat of the American Flag Fish or Everglades Minnow, *Jordanella floridae*?

This species is an inhabitant of slow streams and swamps, and ranges from Florida to Yucatan.

431. What are the colors and breeding habits of the American Flag Fish?

The gray green body is spotted with black in both sexes and checkered in the female. In the male it is dotted with red, besides which he is marked with horizontal rows of red and green scales and his fins are longer and sharper than those of the female. The dorsal fin is fawn color and bears a black spot at its posterior base.

The average specimen measures about one and one-half inches, though a maximum of two and one-half may be attained.

The male is an ardent wooer like the male Guppy, and when the pair are side by side among the vegetation he curls his anal fin about the female as well as its limited proportions permit, helping her extrude the eggs while he fertilizes them, a few at a time over a period of about two hours. The fry emerge in seven days at a temperature of 68° if the eggs are safeguarded. The male will protect them. The fry are not difficult to rear if supplied with infusorians and given a tank overgrown with algæ. They also accept prepared foods.

This is an aggressive, ill-natured fish, which will rip the tails of Goldfishes and other larger, quickly moving fishes such as Shiners.

The American Flag Fish is an omnivorous species, consuming both animal and vegetable substances. Its food resembles that of the Guppy both in a natural state and in the aquarium.

The name "American Flag" is given the fish because in the male a series of red horizontal dots unites to form stripes.

432. What are the colors and habits of the Ocellated Killie (*Leptolucania ommata*)?

This Killie, found among the river vegetation along the borders of the Indian and Santa Fe Rivers in Florida, reaches a maximum length of one and one-half inches, and is sufficiently hardy to spawn in captivity. The eggs are dropped among plants at a temperature of 75° to 78° and hatch in a little over a week. The fry can be reared the same as Goldfish fry. (See No. 667.) Adults take also Goldfish foods, and appreciate live foods.

The name derives from the eye spot (ocellus) present in both sexes on the caudal peduncle. A second sometimes is seen at the center of the body, below the lateral stripe, in the female.

433. What are the colors and habits of Goode's Minnow (*Chriopeops goodei*)?

This little fish abounds in the Florida Everglades and in the rivers and sulphur springs of eastern Florida. It is of a mild nature, and thrives in the home aquarium. Its maximum length is one and one-half inches. It breeds in the same manner as the Ocellated Killie.

The colors are gray green above, silver below. An irregular lateral band, sometimes bordered with orange yellow, runs from the tip of the snout to the caudal peduncle, where it ends in a black spot set in russet or yellow. The fins are plain in the female, all except caudal and pectorals being rimmed with black in the male. The body color

is chrome, on which runs a prominent lateral stripe from gill covers to tail. The male is banded posteriorly with vertical bars, and his large dorsal and anal fins match the body color and are bordered with a darker stripe, brown or bluish. The fins of the female are hyaline.

SILVERSIDES OR HARDHEADS

(FAMILY ATHERINIDÆ)

434. What is the habitat of the Australian Rainbow Fish, *Melanotænia nigrans*?

The coastal streams of central and eastern Australia are the home of this species.

435. What are the colors and breeding habits of the Australian Rainbow Fish?

The compressed body, fusiform in shape, is light brown, the ventral region gray to light pink. Scales on the sides are iridescent, showing red, blue, yellow, green and lavender tints. The two dorsals, anal and caudal fins are yellowish near the body and edged with black. Gill covers reflect green, red and yellow in different lights.

Of the two dorsal fins, the first is small, while the second begins at the middle of the body and extends almost to the caudal base. The anal fin is longer than the second dorsal.

The average length is three inches, maximum four.

Females usually are larger and plainer than males. The posterior tips of the male's dorsal and anal fins are pointed, while in the female they are rounded.

One hundred and fifty to 200 light yellow eggs are deposited on fine leaved plants throughout the aquarium. They hatch in 48 to 60 hours and the fry may be seen clinging to the plants and the sides of the aquarium for two days. After this period they swim freely and must be given infusoria and baby fish foods.

The water temperature generally should be 70°, 80° for spawning.

This is a hardy and peaceable species, accepts almost any food offered and is very fond of algæ.

436. What is the habitat of the Hardhead, *Craterocephalus nouhuysi*?

This little fish comes from Australia, where it lives in the Lorentz River and its tributaries.

437. What are the colors and foods of the Hardhead?

The sides and back are olive green to light brown, with vertical black bands, sometimes numbering 11 or more, which alternate with light golden brown. A black band extends from the snout to the base of the caudal fin, and is bordered above with a light golden stripe. All the fins are clear except the dorsal and ventrals, which are mottled with silver and black. The belly is grayish silver, and presents a fluted appearance like a washboard. The scales are hard.

This species has not yet bred in captivity. Its maximum length is three inches. Its disposition is good.

Sexes are distinguished by the more slender body of the male; also, his fins are more colorful.

It accepts any food offered, but prefers live food. Mr. Elgin Wigham, who first received this species from Australia, noticed its strong appetite for *Hydra*.

A water temperature of about 75° is suitable for the Hardhead, and specimens imported two years ago are still living.

THE ARCHER FISH**(FAMILY TOXOTIDÆ)****438. What is the habitat of the Archer Fish or Shooting Fish (*Toxotes jaculator*)?**

Most specimens seen in the United States are from Singapore. On East Indian and Polynesian shores the fish is found in salt and brackish water and enters fresh water.

439. What are the colors and habits of the Archer Fish?

It is green, with six or seven dark brown and green vertical "thumb marks" on each side. Narrow ones run through the eye and caudal peduncle. The fish is perchlike in shape, the female more rounded. The perpendicular slant of the mouth in the pointed snout aids in the habit of shooting water.

Aquarium specimens seldom exceed four inches in length, but the species is said to reach six inches.

The Shooting Fish requires warm water, 78° to 80°, and can be maintained in salt, brackish or fresh water.

The food consists of insects, beetles and bugs, at which the fish directs a stream of water from its mouth as they are resting on plants or grass above the surface. The jet dislodges them and the fish captures them as they fall.



Photograph by Carl Rabe

This Archer fish lives in salt water in the Steinhart Aquarium, but can be kept also in brackish or fresh water. It eats insects and bugs, directing a stream of water at them from its mouth as they rest above the surface. The jet dislodges them and the fish captures them as they fall.

In captivity, all sorts of winged insects, also enchytræids and wax-worms, prove acceptable.

The Archer is a decidedly desirable fish for the aquarium and very interesting if one can supply plenty of live food. It grows very tame and is always ready to shoot.

It has not bred in captivity

BADIS BADIS, KING COSCOROB OR *POLYCENTRUS SCHOMBURGI*,
AND BEARDED *POLYACANTHUS*

(FAMILY NANDIDÆ)

440. What are Nandidæ?

They are a family of Oriental, Perchlike fishes, oblong in form and called the Fishes with Transparent Tails. Very few have reached the home aquarium, their nervous habit of hiding in vegetation making them difficult to capture.

Their habitat is South America, the British West Indies, Africa and India. •

441. What are the characteristics of the Nandidæ?

They are extremely nervous, high-strung little fishes, which require a quiet, thickly planted tank, where they can dart in and out among the vegetation and feel sheltered. Frequently the females are smaller than the males. •

442. What preparati^ons are necessary for breeding the *Nandidæ*?

Give them empty shells or small flower pots, plenty of plants and some smooth stones.

443. What is the habitat of *Badis badis*?

Eastern India.

444. What are the colors and breeding habits of *Badis badis*?

Colors vary according to mood. Stripes of yellow appear on a brown and blue body, with 10 or more black vertical bands. The long dorsal fin may be tipped with white at its summit, or may show a rich black horizontal bar, dotted with white along the line of the body. Black bands may extend from the dorsal fin forward through the eyes. The fins are beautifully rounded. The ventral profile of the male is concave, that of the female convex. Also, the male in this species commonly is the larger of the two and more richly colored.

Under the stress of emotion, caused by the approach of human beings or the introduction of other fishes into the tank, the colors deepen and a blue green sheen flits across the sides as the shy little fish seeks to secrete itself among the plants.

Mr. A. E. Hodge found this species much more active by night, as many fishes are.

When the fishes are ready to spawn, they seek an empty shell or other similar ready-to-hand nest (it is customary to provide them with a small flower pot in the aquarium), and here the eggs are laid and fertilized, the father remaining in the vicinity to protect them against spawn-eaters and to keep them aerated with a gentle fanning of his fins. In about three days the fry leave the eggs, and when they rise to swim and feed it is well to remove the parents to another aquarium, for, fishlike, their devotion is a fickle and transient thing.

The average length is about three inches.

Temperature of the water generally should be 70°, 75° for spawning.

Live foods, meat, fish and shellfish are the foods preferred.

445. What is the habitat of the King Coscorob, or Black Coscorob, *Polycentrus schomburgki*?

It is taken in British Guiana, Venezuela and the island of Trinidad, where it lives in thickets of aquatic plants and in the rank grasses which border watery ravines and lakes.

446. What are the colors and breeding habits of the King Coscorob?

This species is decidedly variable. Usually the color is black, with blue spotted vertical bands. It changes almost instantly from black to white or pink and may also become spotted with white when frightened.



Photograph by Dr. E. Bader

The King Coscorob (*Polycentrus schomburgki*) has a maximum length of three inches, and is a nervous little fish which, when frightened, remains where it is instead of swimming away, turns pale and vibrates its transparent fins in an excited manner, while trying to flatten itself against the plants or stones.

The male is larger and as a rule darker than his mate, shading from brown to black, but he becomes spotted with white during the breeding season.

The breeding habits are similar to those of the *Badis badis*, though the eggs may be deposited in a spot selected among the plants, as well as in a shell or flower pot. The father remains on guard and the young hatch in about four days. They hang to the nest by a thread the first day. It is customary to remove the mother after she has spawned and the father when the babies become free swimming.

The water temperature generally should be 70°, 72° for spawning. The average length is two inches, maximum three.

Small invertebrates form the food of this species which is a

mosquito destroyer in its native haunts, and the preference is for live food, such as small crustaceans, worms and flies.

447. What are some interesting facts about the King Coscorob, *P. schomburgki*?

The little fish is said to have been named after a German botanist, Moritz Richard Schomburgk, who traveled in British Guiana with his equally distinguished brother, Robert Hermann Schomburgk. The latter became Anglicized, was knighted in England, and introduced the *Victoria regia* to Europe, from whence it found its way to the United States. We are therefore indebted to the two brothers for their contributions to the home aquarium and the garden pool. Both published accounts of new fishes found in British Guiana and each had some of these named for him.

When frightened, this fish remains where it is instead of swimming away, rapidly vibrating its fins in an excited manner, turning pale and attempting to flatten itself against the plants or stones as it veers to one side in a crouching position.

448. What is the habitat of the Bearded *Polyacanthus* or Leaf-fish (*Monocirrhus polyacanthus*)?

The upper Amazon and its tributaries are the habitat of this species.

449. What are the colors and breeding habits of the Leaf-fish?

The strongly compressed body, with long pointed snout, is a dark brown, dead leaf color and also leaf shaped. From the chin depends the short, soft appendage like a little beard, which gives the fish its generic name of *Monocirrhus*—one cirrus or appendage. As in all the Nandids the fins are for the most part colorless.

The eggs are adhesive and become attached to plants such as *Sagittaria* and *Vallisneria*, where they are fanned by the father fish. They hatch in four days and the fry are easy to rear on minute live foods—Daphnia, brine shrimps freshly hatched, and the like. Later they take live Guppy fry. They remain suspended from the leaf for a day or two and then leave to swim and feed.

The water temperature generally should be 70°, raised to 80° for spawning.

Most of the few specimens thus far seen in the United States measured about two and one-half inches, but a maximum of four is said to be attained.

450. What are the characteristics of the Leaf-fish?

It has a curious habit of swimming head down like the Pencil Fish, has a cavernous mouth and bears a strong resemblance to a floating leaf. The deception is such that many specimens have been captured for home aquarium purposes.

It is able to fool other fishes as well as human beings, and taking advantage of its deceptively leaflike appearance, subsists almost exclusively on a fish diet. It approaches its prey like a floating leaf and then quickly gulps it down.

Its preference is for small live fishes.

THE PIGMY SUNFISHES

(FAMILY ELASSOMIDÆ)

451. Have Pigmy Sunfishes bred in captivity?

Southern Pigmies have bred in captivity. The eggs are amber and fry invisible to any but a trained eye. The parents are said not to be cannibals and not to guard the eggs and young.

452. What are the range and habitat of the Pigmy Sunfish, *Elassoma zonatum*?

From Texas, Alabama, Arkansas and Louisiana north to southern Illinois, it is found in sluggish streams, swamps and bayous. It is more abundant southward and may be taken in company with *Gambusia* and *Heterandria*.

453. What is the color and disposition of the Pigmy Sunfish?

The color is subject to some variation; but generally it is olive green, finely punctulate all over. On the side is a conspicuous, roundish black spot nearly as large as the eye, also about 11 parallel indistinct vertical bars of dark olive. The soft fins are faintly barred and at the base of the caudal lies another blackish bar.

The average length is one and one-half inches, the maximum two and one-half.

This Sunfish usually is well-behaved in company with larger species, but at times is given to fighting.

454. What are the range and habitat of the Everglades Pigmy Sunfish (*Elassoma evergladei*)?

In Georgia and Florida it is found in sluggish streams and swamps. Its abundance in dark waters tributary to the Everglades gave it

its specific name, its small size being indicated by the generic name, *Elasmoma*, which in Greek means diminutive.

455. What are the colors and breeding habits of the Everglades Pigmy Sunfish?

The color varies greatly, but quite often it is green or fawn, males usually showing some black on fins and body in faint bands, and this color spreads over the sides in the mating season, when they become dotted with gold and emerald.

The males engage in spirited gymnastics and colorful combats, in which no one is hurt. When mating finally occurs, the eggs are deposited among plants through the aquarium. It is not necessary to remove the adults if the tank is well planted. The fry hatch in two or three days and may number upwards of 50.

Males seldom exceed one inch in length, females attaining to one and one-quarter inches.

This Sunfish is uniformly gentle. It does well at 73° and can be kept in an outdoor pool all year in California from San Francisco south and during the summer in the middle western and eastern states. It is not affected by slight changes to lower temperature.

456. How can the Everglades Pigmy Sunfish be distinguished from the Pigmy Sunfish?

The Everglades Pigmy lacks the black spot on the side and his anal and caudal fins are conspicuously marked with cross bands formed by dark dots.

THE GLASS FISHES

(FAMILY AMBASSIDÆ, FORMERLY SERRANIDÆ OR SEA BASSES)

457. What is the habitat of the Indian Glass Fish or Golden Bass (*Ambassis lala*)?

It is a native of India, found in fresh and brackish water.

458. What are the colors and breeding habits of the Indian Glass Fish?

The body of both sexes is a glassy golden amber, changing at times to a transparent green. The male's dorsal, anal and caudal fins are marked with light red, and have blue edges. The colors are much more pronounced in both sexes during the breeding season.

Both sexes average about one and one quarter inches, with a maximum of nearly two.

Breeding occurs in late spring and summer, and this fish will live and breed at a temperature of from 75° to 80°.

The eggs are deposited among the fine leaved plants in lots of four to eight until 40 or more have been laid. They are very small, clear and transparent, and hatch in 24 to 36 hours. The fry cling to the plants or sides of the aquarium for two days or longer. Remove the parents after spawning is complete. The young are difficult to rear.

Very few artificial foods are acceptable, this species preferring white worms, brine shrimps, *Daphnia* and other live foods.

459. What are the interesting features about the Indian Glass Fish?

Its body is thin and so transparent that the roe is visible during the spawning season. It is rather shy and quick of movement, and amiable by nature. It will survive in the aquarium for from eight months to one and one-half years. It is well protected by two sharp spines, one on the dorsal fin, one on the anal fin. Larger fishes never attempt to swallow it because of this protection.

460. How is *Ambassis lala* distinguished from *A. commersoni*?

Commersoni is much longer, with a slenderer body and black-edged fins.

461. What are the range and habitat of the African Glass Fish, *Ambassis commersoni* (or *A. ambassis*)?

This species is found in eastern Africa and northern Australia, in fresh and brackish water.

462. What are the colors and habits of the African Glass Fish?

The elongated body is olivaceous with a transparent, brassy sheen. Sometimes a dark silvery band extends from the gill covers to the base of the caudal. The anterior tip of the dorsal and the lobes of the caudal are black.

The average length of both sexes is three inches, maximum six.

This species has not been bred. It is so rare that in 1935 only two persons in San Francisco owned it.

It appears to prefer brackish water, with a temperature of 75° to 80°.

Smaller fishes, insects and worms form the natural foods. In captivity it accepts any prepared food, but prefers live food.

LABYRINTH FISHES

463. What is a Labyrinth fish?

The word Labyrinth is an abbreviation of Labyrinthici, applied in ichthyology to a group of Asiatic fishes in which a labyrinthine chamber, situated above the gills and richly supplied with blood vessels, enables the animals to breathe air. Fishes in this group drown if prevented from reaching the surface for atmospheric air as the gills are not equipped to provide them with sufficient oxygen. They do not appear to suffer in crowded quarters and foul water. Some other fishes breathe air, but the "Labyrinth fishes" of the amateur aquarist are the Climbing Perch, Paradise Fishes, Gouramis, Fighting Fishes, Channas and Pike Head. Of these, the Paradise Fishes, Gouramis and most of the Fighting Fishes build bubble nests in which the eggs are incubated.

464. What is a bubble-nest builder?

A bubble-nest builder is a fish which blows a nest of bubbles at the surface of the water. Usually the males blow the bubble nests, but a number of cases have been observed, especially in Paradise Fishes, in which the female has built a nest; also in which both male and female have watched over the eggs and young. Sometimes the male will destroy a nest built by the female, and it is well to let her have her nest with a few of the eggs, and partition off her side of the aquarium with a sheet of glass.

465. What is the construction and function of the bubble-nest?

All such nests are constructed of bubbles blown at the surface. In some species the nest is built among floating leaves and bits of plants. A mouthful of air, carried below, is coated with a sticky buccal secretion, and when released remains at the surface in the form of bubbles. Many hundreds of such bubbles together make up the floating nest—which, after one or two hours of labor, appears as a dome-shaped structure which reaches a height of one-half inch to two inches and a diameter of from two to six inches. The nest is kept constantly in repair, bubbles that burst being replaced with fresh ones.

When the nest is finished, the female is introduced, provided she is ready to spawn—which will be very evident from the distended abdomen. After much courting and a wonderful display of colors and spreading of fins, especially by the male, the female is coaxed under

the nest. The male entwines his body about hers, remaining thus for 10 or 15 seconds, then disengages her.

In some species the eggs float up into the nest after fertilization. In others they sink, and the male, stationing himself beneath the female, catches them in his mouth as they fall and blows them into the nest, after attaching one or more bubbles. From two to 12 are expelled at a time, and this ceremony is repeated every few minutes for an hour or two until from 70 to 400 or more eggs have been dropped. They are the size of a small pin-head and hatch in from 36 to 48 hours.

The female should be removed as soon as the spawning is completed, otherwise the male will injure or kill her in his efforts to drive her away from the spawn. When the young hatch, they are threadlike and about one-sixteenth of an inch in length. They hang from the nest, tail down, and if any fall to the bottom the male picks them up in his mouth and blows them into the nest again.

When the little yolk sac is absorbed (in about four days) the fry are free swimming and at this stage it is best to remove the father if the majority of the young are to be saved. A constant temperature of 75° to 85° should be maintained, especially when the incubation period is in progress. A tank of five gallons' capacity (not too deep) usually will be found ample for the smaller species, and should be well planted with *Anacharis*, *Sagittaria* and *Riccia*. Infusoria should be given at least four times each day for the first three weeks, also, if procurable, small *Daphnia* or newly hatched brine shrimps.

BUBBLE-NEST BUILDERS—PARADISE FISHES, *BETTAS*, GOURAMIS

(FAMILY ANABANTIDÆ)

466. What are the range and habitat of the Paradise Fish (*Macropodus opercularis*, formerly *M. opercularis viridivirens*)?

In Africa and southeastern Asia, notably China, this species makes its home in swamps and rice fields.

467. What are the normal and breeding colors of the Paradise Fish?

The colors and markings of this species are subject to great variation. When nothing exciting is taking place in the aquarium the male assumes a warm brown with darker vertical bands. A change of temperature, the introduction of food or a companion, and there is a rapid change of hue. His sides become vertically striped with

scintillating red, violet and greenish blue in about 12 alternate bands. These colors also dominate in the fins, whose reds and browns may alternate with light and dark blue and violet. The margins of the dorsal and anal may become bluish purple, the red of the caudal may show violet stripes and the long ventrals become bluish at the base, their ends red or cream color, while a bluish green spot edged with orange appears on the gill covers. The female is drab by comparison and turns almost white during the breeding season when the male is flashing his brightest colors for her admiration.

The average length of this species is three inches.

The Albino Paradise is of this species.

468. What are the breeding habits of the Paradise Fish?

Spawning occurs at frequent intervals throughout the summer. A bubble nest is blown, which, when finished, looks like a handful of grayish white froth. The male embraces the female much as the Horned Dace embraces his mate, fertilizing the eggs as she drops them. During several embraces, from 200 to 500 are expelled and the male transfers them to the nest. The young hatch in from 36 to 48 hours and measure one-sixteenth of an inch in length.

Motion pictures have been made of the courtship and egg laying of the Paradise Fish. (See also Nos. 464 and 465.)

The sexes are easily distinguished in this species. The male is more highly colored and his fins are much longer, ending in long, threadlike filaments, especially his dorsal, anal and caudal fins.

The water temperature should be (for comfort) 65°, for breeding, 72° to 75°. This species is resistant to great variations in temperature—from just above freezing to 90°.

469. What are some interesting features of the Paradise Fish?

It was the first bubble-nest builder known to the aquarist and was introduced into the Occident more than half a century ago. It has been familiar in America for nearly 30 years, having been one of the first of the toy tropicals to reach this country.

This is an intelligent fish, but an ill-natured bully, and males especially are best kept each by himself. Like the Killifishes they notice much that goes on outside the aquarium, watching their owner eagerly through the glass and following his movements with lively curiosity.

Mrs. Edith W. Berwyn, while living in New York, kept Paradise Fishes in home aquaria and noticed that the females have a strong eye for color, especially red. She made them happy by placing spools



From Nature's Wonderland, by Kingsley and Breck

Paradise Fishes (*Macropodus opercularis*)

Among these beautiful, intelligent but quarrelsome little fishes from Asia, the male builds a bubble nest at the surface of the water, where the eggs are placed and cared for by him. He is distinguished by his higher color and longer, larger fins.

of bright silk thread in front of the aquaria, with which the little fishes evidenced their delight for hours at a time. Shining objects also attracted them and when crocheting or sewing she noticed that they followed her needle or thimble. Now, in California, she maintains Paradise Fishes in an outdoor pool and they eat from her fingers.

This is a strong and hardy species, though not desirable for the community tank. It has a record of eight years' survival in captivity.

Complete sex reversal from female to male has occurred in this species.

470. What are the foods of the Paradise Fish?

Flies and other insects, with some of the finer swamp vegetation, form the natural foods.

In captivity, the Paradise Fish is a boarder easily accommodated, and will take anything that a Goldfish will accept, though showing a preference for fish and meat. Minced clam, worms, mosquito larvae, Daphnia and brine shrimps are appreciated, as well as scraped meat and fish, prepared foods and cereals.

471. What is the habitat of Day's Paradise Fish, *Macropodus cupanus dayi* (formerly *Polyacanthus dayi*)?

India.

472. What are the colors of Day's Paradise Fish?

The back is dark brown, the lower portions of the body reddish. Two dark stripes extend from the gill covers to the base of the caudal, and the head is spotted with brown. The margins of the reddish brown fins are bluish white. The dorsal is spotted with dark brown, and the tips of the anal and caudal fins are red except for the lengthened middle rays of the caudal, which are deep blue.

Day's Paradise Fish, sometimes called *Polyacanthus dayi*, is very hardy though not as prolific as the Paradise Fish. Its breeding habits, size and foods are the same as those of the Paradise Fish.

M. cupanus is less colorful than *dayi*, light instead of dark brown, and with gray fins dotted with red and edged with pale blue.

473. What is the habitat of the Round Tail Paradise Fish, *Macropodus chinensis*?

China and Korea.

474. What are the colors and breeding habits of the Round Tail Paradise Fish?

Brown and green are the colors, with seven or more almost black vertical bands, some of which coalesce. The male is much darker in the mating season. The female is plain, with shorter fins.

A length of nearly three inches is attained.

The propagation in this species is the same as in the Paradise Fish, *M. opercularis*, but it is not as prolific.

475. How can one distinguish between the Paradise Fish and the Round Tail Paradise?

The rounded caudal fin immediately distinguishes the Round Tail. Also, its vertical bands are less distinct.

476. Which fishes are called Bettas?

Some half dozen fishes of the genus *Betta* have reached the United States from the Orient during the past 25 years, the first of which was *Betta splendens*. This species and *Betta bellica* are bubble-nest builders, but some of the Bettas are Mouthbreeders, as *B. brederi* and others.

477. Do nest building Bettas thrive in acid or alkaline water?

They appear to prefer slightly acid water, though Mr. Lanier has raised many in alkaline water.

478. What is the number of eggs produced by the nest building Bettas during one spawning?

This varies with the size and age of the fishes. From 40 to 600 or more may be expected. (See also No. 50.)

479. Why do the fry of nest building Bettas die in large numbers a few weeks after hatching?

The loss is due largely to too limited feeding with infusoria, which should be given at least four times a day; also because of too low water temperature.

480. When should the male Betta of nest building species be removed from the aquarium?

Usually when the young are about four days old. In fact, most of the young will be saved if the male is removed as soon as they hatch, though this deprives one of the pleasure of observing his

watchful care of his babies. Also, if the tank is moved when the eggs or young are in the nest, many will fall to the bottom and be lost if the father is not present to replace them. The explanation is that the fry must breathe air and can get it only near the surface among the bubbles.

481. What foods will the nest building *Bettas* accept?

They are naturally carnivorous and like garden worms, fish roe, wax-worms, minced meat and shellfish, *Daphnia*, white worms and live brine shrimps. They will take also prepared foods.

482. What is the habitat of the Siamese Fighting Fish, *Betta splendens*?

Siam, southern China and the Malay Peninsula (Malacca) are its habitat, where it lives in shallow waters.

483. What are the colors of the Siamese Fighting Fish?

The compressed body displays blue, green, and various tints of red over brown, and is remarkable for its changes of color resulting from fright or other emotion, or from alterations in temperature. Through careful breeding in Germany and America, handsome flowing fins have been developed which are a delight to the eye. Moreover, new and beautiful colors have arisen from crossings of this species with the Cambodia *Betta*, and solid colors such as blue, lavender, green and red have been created, so that a number of variants now are known, as Gneiding's Red *Betta*, Cornflower Blue *Betta*, Locke's Blue *Betta*, and so on. There is no end to the number of breeds that may yet be produced by artificial selection.

The average length is two inches with a maximum of two and one-half.

484. What are the breeding habits of the Siamese Fighting Fish?

An air bubble-nest is blown at the surface of the water by the male, as described in No. 465, floating vegetation sometimes being enclosed within the flimsy arrangement which, when complete, looks like a circle of lather. The female, treated like a child which may watch Santa Claus trim the tree but must not touch the contraptions, peeks out at her lord and master from some hiding place among the plants until he dons his most gorgeous coat for her admiring eye and invites her to view his masterpiece—the cradle he has built for her offspring which he proposes to sire. She responds to his allure-

ments by spreading her own fins and swimming under the nest, where she takes a semi-vertical position and is embraced by the male in the same manner as described for the Horned Dace (No. 731). The nuptials extend over a period of more than an hour. The eggs number over 200 and after fertilization are placed in the nest by the father. They hatch in from 36 to 48 hours and the fry keep dropping out of the nest for several days before their yolk sacs are absorbed and they are able to balance themselves and try their little fins. The father is safe with them for a week or two (perhaps a little longer), but when his taste for fish grows stronger than his paternal devotion, his appetite is not to be gainsaid, and the observing aquarist, if he would save the fishlets, must remove him before he feasts upon them.

The little ones mature in about six months.

The temperature of the water should be 75° generally, raised to 80° for spawning. The colors are brighter in the higher temperatures.

Experiments made with *Betta splendens* at Wesleyan University by Dr. H. B. Goodrich and Hoyt C. Taylor show that the rate of deposition of yolk in the ova depends upon the temperature of the water; and this doubtless holds true with other toy tropical freshwater species, including live-bearers, for an old time Guppy dealer discovered that his Guppies would breed much faster if he set the tank on top of the warm stove pipe. Though *Bettas* breed frequently enough to suit the aquarist, it was established as a biological fact that they could be bred much faster if a plentiful supply of females were at hand, for males, at a temperature of 80°, will breed continuously every two or three days. Females cannot breed oftener than every seven days at the same temperature, this time being required to deposit the necessary quantity of yolk in the ova; and they breed at uniformly longer intervals at lower temperatures.

485. What are the characteristics of the Siamese Fighting Fish?

This is said to be the species from whose fights royal revenues were derived for many years in Siam. Dr. Hugh M. Smith advises us that fights with *Betta splendens* still are common in Bangkok and other places in Siam, and "there are licensed places where formal combats are held and wagers made, but most of the fighting is in private houses and without betting or for very small wagers."

The males of this species are more pugnacious than dogs or roosters, and with their little bodies flashing imitations of almost every namable gem, their handsome fins spread proudly like a turkey's tail, and their gill covers expanded, they assail their rivals with fierce mien and damaging, if not fatal consequences. The fight is considered won by the fish which still is willing to battle after his

opponent quits. Then it is customary to remove the latter before he is killed.

If a mirror is placed against the glass of an aquarium containing a male *Betta splendens*, his excitement is immediate, as he exhibits his readiness for combat with the usual display of color and spreading of fins and gill covers.

Fighting begins when males are three months old and then it becomes necessary to separate them. As a rule, Fighting Fishes are reared singly in small jars, and those who wish their fishes to match their draperies are disappointed because the lovely blues and reds of these gorgeous creatures cannot be massed.

Complete sex reversal from female to male has occurred in this species.

486. When was the Siamese Fighting Fish introduced into the United States?

Between 1908 and 1910, before Guppies and Swordtails were known here. This species was introduced into Europe not long after the arrival there of the Paradise Fish.*

487. How long will the Siamese Fighting Fish survive in captivity?

From one to two and one-half years.

488. What is the habitat of the Cambodia *Betta splendens*?

The name Cambodia derives from the province of Cambodia in French Indo-China, where this breed of Fighting Fish long has been known.

Dr. Hugh M. Smith, under date of February 12, 1935, informs us as follows:

"I have never had any evidence that the Cambodia *Betta splendens* occurs anywhere in a wild state. All my information indicates that it originated under domestication in Cambodia or Saigon about forty years ago. It is now extensively cultivated in Siam."

489. What are the colors and spawning habits of the Cambodia?

This variation of the Siamese Fighting Fish is pink as an albino, though not a true albino, with trailing dusky colored blood red.

The spawning habits are the same as those of the Siamese Fighting Fish. Males have blown new nests eight days after the first spawning, and 360 eggs have been counted in one nest.

* We are indebted to Mr. Herman Rabenau for this information.

490. When were the Veiltail *Betta splendens* and Cambodia *B. splendens* introduced into the United States?

They were introduced about 18 years after the arrival of the Siamese Fighting Fish. Two original shipments arrived in San Francisco about May, 1927. The first was received by Mr. Frank S. Locke, well known aquarist, from whose successful breeding these two breeds spread over the country. A few days later, Dr. Hugh M. Smith, then Adviser in Fisheries to His Siamese Majesty's Government, presented to Mr. Alvin Seale, Superintendent of the Steinhart Aquarium, two pairs of *Betta splendens*. One was blue (the Veiltail), the other had a creamy body with long red fins (the Cambodia). From these fishes Mr. Seale reared many fine offspring for public display.

491. What is the habitat of the *Betta bellica*?

The Malay Peninsula.

492. What are the colors and breeding habits of the *Betta bellica*?

The back is dark brown, the sides light brown. The scales are spotted with green dots which form six lines on the sides. The fins are reddish brown, and bars of the same color usually run from the head to the tail. The male's anal fin and the lower portion of his caudal fin are brilliant red.

The maximum length is two and one-half inches.

Like the other Fighting Fishes, this species breeds throughout the year if ideal conditions are provided. The male builds a bubble nest and cares for the eggs. He is not as pugnacious as the male *Betta splendens*, but when spawning is complete, the female should be removed. The fry emerge from the eggs in from 36 to 40 hours.

The water temperature generally should be 75°, raised to 82° for spawning.

This *Betta* has survived for three and one-half years in captivity.

Some fanciers regard it as a variant of *B. splendens*.

493. What is the habitat of the Dwarf Gourami (*Colisa lalia*)?

British India is the home of this species.

494. What are the colors and breeding habits of the Dwarf Gourami?

In the male the compressed, ovoid body is banded perpendicularly with red and blue and his red- or blue-margined fins are dotted with

rubies. In the female, the outer form is similar, the body colors not so vivid, and the fins pale.

A length of not more than two inches is the maximum for this species which, as its name implies, is the smallest of the Gouramis.

Breeding takes place several times during the summer at a temperature of 75°. A bubble nest is blown among the surface plants, five or six inches in diameter, which the male guards with a jealousy that may prove fatal to the female if she is left in the breeding tank. (See Nos. 464, 465.) The fry, numbering several hundred in one nest, hatch in from one to three days and the father should be relieved of his duties when they become free swimming as his memory is short and he may mistake his youngsters for edibles. They leave the nest a few days after hatching and require infusoria and the usual baby fish foods. (See No. 192.) The males of most Gouramis blow the eggs up into the nest, but in the case of the Thick-lipped and Striped Gouramis they are light enough to float into the nest.

The temperature of the water generally and also for spawning should be 70° to 75°. Some aquarists raise the temperature to 80° for breeding.

495. What are the characteristics of the Dwarf Gourami?

It frequently visits the surface for air like other Labyrinth fishes, is fond of resting out of sight among the vegetation and is attractive chiefly because of its breeding habits and the long, slender proliferations of the ventral fins, like grotesque little fingers pointing this way and that, or like stilts which one expects it to put down and walk on. Actually they serve as tactile organs to determine the nature of the surroundings and probably the presence of inconspicuous prey. Its nature is of the best.

It will survive in the aquarium for from two to four years.

496. What are the foods of the Dwarf Gourami?

This little fish is omnivorous, consuming aquatic plants along with an insect-crustacean-aquatic worm fare in its native haunts. Prepared foods are taken, and scraped beef, liver, fish and shellfish are appreciated; also fuzzy plants.

497. What is the habitat of the Thick-lipped Gourami, *Colisa labiosa*?

India and the Malay Peninsula.

498. What are the colors and spawning habits of the Thick-lipped Gourami?

The sides are fish green, slightly darker at the front of the body, the back is reddish brown, and over these plainer colors there is spread a bluish sheen. A wide horizontal band, extending from the mouth into the base of the caudal fin and terminating in a round blue metallic spot, is crossed by 10 or 12 vertical bands of violet red. All the unpaired fins are blue or bluish green, with an orange margin. The colors are similar in both sexes, but duller in the female, which is also distinguished by the rounded dorsal fin. The lips are thicker in the males. The ventral fins bear the long filaments which characterize the Gouramis. The body is narrower than that of *C. lalia*.

The maximum length is three inches.

This Gourami will survive for from two to four years in captivity.

The breeding habits and foods are the same as those of the Dwarf Gourami. (See Nos. 494, 496.)

The nature of this species is gentle, the body robust.

499. What is the habitat of the Striped Gourami, *Colisa fasciata*?

India and the Malay Peninsula.

500. What are the colors and breeding habits of the Striped Gourami?

The long greenish brown body is perpendicularly striped with dark brown (sea blue and orange red alternating in spawning time) in 10 or 12 prominent bands. Reddish spots appear on the iris, the fins are blue and green, spotted with banana red and edged with the same color. The typical Gourami ventrals are present, with long, tactile filaments which can be turned in any direction.

The breeding habits are the same as those of the Dwarf Gourami, but the young are more easily reared.

The average length is two or three inches, maximum four.

501. What is the habitat of the East Indian Gourami, or Giant Gourami, *Osphronemus gourami* (formerly *O. olfax*)?

The Dutch East Indies, Siam and Malay Peninsula.

502. What are the colors and breeding habits of the East Indian Gourami?

The young specimens which have been familiar to American aquarists for the last 20 years are large-scaled, large-eyed and large-finned, with the characteristic Gourami "feelers" on the ventral fins. The brown body is chunky, displays a greenish sheen, and is vertically banded with eight or 10 stripes running from the back to the belly. There are two black spots, one below and behind the



Courtesy John G. Shedd Aquarium

The East Indian Gourami

This is a giant among Gouramis, attaining a length of 24 inches in its native waters. The pupil of the eye is pear-shaped as in many fishes of larger size, the apex pointing toward the mouth.

pectoral and one in front of the caudal peduncle. The pupil of the eye is pear-shaped, as in many fishes of larger size, the apex pointing toward the mouth.

This species is said to breed at two years, the habits being like those of the Dwarf Gourami. (See Nos. 465, 494.)

This is a very pugnacious fish, and a giant among Gouramis, attaining a length of 24 inches in its native waters, where it is an important food species. Specimens for aquariums seldom exceed four inches.

Fishes of this species have survived for four years in the aquarium on a diet of beef heart, which is taken in strips, live minnows and live shrimps of both fresh and salt water.

503. What is the habitat of the Three-spot Gourami or Hair-fin (*Trichogaster trichopterus*)?

This species is indigenous to British India, the Malay Peninsula, Dutch East Indies, Cochin-China and Siam.

504. What are the colors and spawning habits of the Three-spot Gourami?

The colors depend on the habitat, as in the case of many tropical species. The body of this species is longer than those of Gouramis of the genus *Colisa* and the fins may be plain fish gray and silver, or may show a light gray background with greenish tinge and red gold or orange spotted "finnage." Ocelli may or may not be present on the caudal peduncle and sides. The name Hair-fin refers to the ventral filaments typical of Gouramis.

The average length is four inches.

The breeding habits and foods are the same as those of the Dwarf Gourami. (See Nos. 494, 496.) This species is particularly fond of Hydra.

505. What is the habitat of the Tessellated or Mosaic Gourami (*Trichogaster leeri*)?

This species extends through the Dutch East Indies and the Malay Peninsula.

506. What are the colors and breeding habits of the Mosaic Gourami?

This species is of much lighter coloration than *T. trichopterus*. It has a silvery jacket which reflects the pinks, blues and lavenders of mother of pearl. An irregular horizontal black band extends from the tip of the snout to about half way across the length of the body, then gradually fades out, ending just below the posterior end of the dorsal fin. An indistinct black spot usually is present at the base of the caudal fin. Because of a dark tessellated body pattern which underlies the jacket of silver, the fish is called the Tessellated or Mosaic Gourami. The under parts are ivory and the brown pupil is surrounded by a silvery iris.

Most specimens average from three to three and one-half inches.

The foods and breeding habits are the same as those of the Dwarf Gourami, which see: (Nos. 494, 496.)

507. What is the habitat of the Kissing Gourami (*Helostoma temminckii*)?

This well known Gourami is of Oriental derivation like other Gouramis, and inhabits the shallow waters of Java, Borneo, Siam, and Sumatra in the Malay Archipelago.

508. What are the colors and breeding habits of the Kissing Gourami?

The colors are plain fish gray and silver in this species, slightly darker in the male.

This Gourami exhibits the same breeding habits and care of the fry as described in the case of the Dwarf Gourami. (See No. 494.) It is one of the larger Gouramis. Most aquarium specimens run from three and one-half to six inches, but a maximum of one foot is attained in its native waters.

509. What are the characteristics of the Kissing Gouramis?

They have the same interesting kissing habit that is common in the Grunts, touching lips with open mouths and pushing each other playfully back and forth. As in the case of the Grunts, their mouths are red.

510. What are the foods of the Kissing Gourami?

This species is largely herbivorous, plants forming the main item in its diet. It likes a prepared food containing lettuce (see No. 187) and also should be provided with a sunny tank well grown with algæ.

CLIMBING PERCHES

(FAMILY ANABANTIDÆ)

511. What is the habitat of the Climbing Perch, *Anabas testudineus*?

Burma in India, Ceylon, Africa, the Philippine Islands and the Malay Archipelago, all claim this interesting fish.

A west African species of Climbing Perch, *Ctenopoma argente-venter*, known as the African Climbing Perch, is similar but much smaller, averaging about three inches, with a maximum of five.

C. nanum, known as the Dwarf Climbing Perch, has a maximum length of three inches and is also an African species.

512. What are the colors and breeding habits of the Climbing Perch?

This species is plainly clothed in a coat of gray green or greenish fawn.

The average length is four inches, with a maximum of 10.



From Nature's Wonderland, by Kingsley and Breck

The Climbing Perch leaves the water, and, supporting itself firmly with its strong fins and the short spines on its pectorals and ventrals, it clambers over the land and climbs up the rough trunks of certain palms. Accessory breathing organs supplement the gills, enabling it to remain out of water for six days. (In this picture, illustrating how the fish "walks," the body is too deep and the tail too stubby. In clambering through vegetation, the pectoral fin is thrown around the stems of plants which the fish wishes to pass.)

The eggs float loosely at the surface of the water, where they hatch in two or three days.

This species does well at living-room temperature, 68° to 72°, is naturally carnivorous, and favors a diet of mealworms, earthworms, chopped fish, meat and shellfish, but will take also dry foods.

513. What are the characteristics of the Climbing Perch.

This is the commonest of the Walking Fishes. On removal from the water it does not flop or lie on its side, but supports itself firmly with its strong pectoral fins, maintaining an upright position, and thus "walks" awkwardly about. The gill covers and ventral fins are armed with short spines which help it to clamber over the sand, and by hooking its pectorals around clumps of grass and plant stems, it secures a leverage and makes a certain amount of progress. It climbs to a height of six feet up the rough trunks of certain palms. Accessory breathing organs supplement the gills, enabling the animal to remain out of water for a period of six days. During the dry season it lives in small, muddy pools.

It is nocturnal and conceals itself in the aquarium vegetation during the day unless lured forth by the prospect of a meal. Mr. F. H. Stoye has seen specimens friendly enough to leap from the water for their food, but those we have known never grew tame though kept for 10 years in an eight gallon aquarium and occasionally taken out for a demonstration of their "walking" ability.

THE CHANNA OR SNAKE-HEAD**(FAMILY CHANNIDÆ)****514. What is the habitat of the Channa, Chinafish, or Snake-head (*Channa fasciata*)?**

This is a Chinese species, now called also *C. asiatica*.

The smaller Striped Snake-head, *Ophioccephalus striatus* (called also *C. lucius*), comes from India. This latter species has a more snakelike appearance, with a longer head and a black bordered yellow lateral stripe; but otherwise it is similar to the well known Channa.

515. What are the colors and breeding habits of the Channa?

The color is fish green above and yellowish white below. There is a lateral band of shimmering silver gray, and an ocellus lies at the base of the caudal fin. The dorsal and anal fins are long and no ventrals are present. There is a faint "thumb mark" behind the gills, and the sides are darkened by irregular vertical and horizontal bands and blotches. On the upper lip are two short barbels.

The average length is about six inches, the maximum 12.

The eggs are buoyant and the fry hatch at the surface. When first laid, the eggs are translucent and light colored. In about 24 hours they begin to grow darker, and when as black as caviar (five

or six days after they are laid), they may be expected to hatch within from 36 to 48 hours at a temperature of 75°. If the temperature is raised to 78° or 80°, the fry will hatch four days after the eggs are laid. Though no nest is built, the father cares for the eggs and young, and the mother also remains on guard to drive away intruders. When live brine shrimps are fed, the parents have been observed to take in the fry with the shrimps and promptly spit out the fry. In fact, they are safe with their babies for two or three months, when cannibalistic tendencies develop.*

The young normally feed on plankton, but in captivity can be given infusoria, prepared foods, egg yolk pressed through a tea strainer, oatmeal juice and tiny particles of shellfish. The adults are voracious, taking a variety of foods, but preferring meat such as Hamburg steak, strips of fish and shellfish, large earthworms and live crustaceans such as brine shrimps.

Except when breeding, the *Channa* may be kept at living-room temperature, 68° to 72°.

This is an intelligent fish, noted also for its hardihood and ability to withstand long journeys in restricted quarters. It becomes exceedingly tame, can "walk" on land, supporting itself on its pectoral fins and wriggling like an Eel. It is very pugnacious, especially after reaching a length of about six inches.

THE PRETTY PIKE-HEAD

(FAMILY LUCIOCEPHALIDÆ)

516. What is the habitat of the Pretty Pike-head, *Luciocephalus pulcher*?

The Dutch East Indies are its habitat, where it lives in the rivers of the Island of Banca; also the Malay Archipelago, and particularly the rivers of Borneo.

517. What are the colors and requirements of the Pretty Pike-head?

The Pretty Pike-head, at first glance, commonly is mistaken for the Mexican Top Minnow, *Belonesox*, the Pikelike body, cylindrical before and compressed behind, the long pointed snout, the rounded caudal fin and the posterior position of the dorsal fin being similar. The jaws also indicate a similar savage nature, and the very short

* For this information, we are indebted to Mr. Herman Rabenau and Mr. Frank S. Locke, who often have bred *Channas*.

intestine betrays a carnivorous appetite. The ventral fins have five rays and one long spine, and the anal is separated into two portions by a deep notch. The fish has no air bladder.

The body is deep fish green to brownish red, yellowish white below. There are reddish marks on the anal fin and the caudal is black with red rays. Old specimens have round blackish spots on the body and fins. A lateral line is present, and one characteristic feature is a broad black band, edged with white, which runs from the snout through the eye to the caudal fin.

The maximum length is six inches.

A temperature of 70° to 75° is suitable.

CICHLIDS OR CHROMIDES

518. What is a Chromide?

Chromides, as far as fresh water is concerned, is another name for fishes in the family Cichlidae, and the word Cichlids now is applied commonly to fishes formerly designated as Chromides.

A small order of salt-water fishes is known as Chromides and includes the family Pomacentridæ, which embraces the Gregorys, Garibaldi and other species desirable for a salt-water aquarium in the home.

519. What is a Cichlid?

The word Cichlid (pronounced Sik'-lid) is from the Greek *kichlē*—a fish, and Cichlidæ is the family grouping for many Perch-like fishes with spines in their fins.

Most of the Cichlids come from Central and South America, Mexico, Trinidad, India, Egypt and other parts of Africa.

Cichlids are attractive because of their interesting breeding habits, and two or three pairs usually are seen in collections of toy tropical fishes. With some aquarists, however, many of the Cichlids are not popular on account of a plant-destroying habit and a pugnacious nature, especially during breeding time.

Most Cichlids are hardy, not sensitive to changes to lower temperatures, and will live for many years in the home aquarium.

520. What are the breeding habits of the Cichlids?

With the exception of Mouthbreeders (a group in which the eggs are carried in the mouth of one of the parents), the Cichlids deposit their spawn on stones, depressions in the sand, or on the roots or leaves of aquatic plants. They hatch in from three to 17 days, depending upon the temperature of the water. Sometimes

one parent assumes full charge of the ova and fry and drives away its mate, but as a rule both parents remain faithful guardians. They aerate the eggs and clear them of sediment by fanning them with their fins, and jointly care for their young. When disturbed, they pick up the fry in their mouths and carry them from one depression to another—a surveillance which sometimes continues for from four to six weeks.

On the other hand, in order to preserve the eggs and rear the young it is necessary in many instances to remove the adults on the second day after the ova are deposited. Most aquarists prefer to take a chance rather than miss the sight of the wonderful parental intelligence and devotion which awaits them if the pair are so inclined.

Fishes of the genus *Aequidens* (formerly *Acara*) are so easily reared that Mr. Walter H. Chute relates that in summer it is a common sight in the Shedd Aquarium to see in one tank of from 10 to 15 gallons' capacity two pairs of *Acara* fanning their eggs, a third pair guarding a flock of young fry, and all taking turns herding the unoccupied adults into one corner of the tank.

Often when a number of Cichlids are introduced into a very large aquarium and are in good condition, they will select their own mates and continue mates for life; but if the aquarist attempts to mate them, a careful watch needs to be kept, for if they dislike each other, fighting will ensue and may prove fatal. If the pair approve of each other, they will lock lips, tug playfully at each other, and at frequent intervals scoop a depression among the plants, indicating a willingness to breed. Cichlids usually spawn again within from four to seven weeks after their first spawning, continuing until from four to six or even more batches are produced during the course of a single year.

To help the little fishes in their efforts to aerate and clean the eggs by fanning them with their fins, an aerator may be placed within one-half inch of the spawn to create a gentle, circulating movement of the water. Mr. Lanier has hatched many batches of Cichlid eggs without compressed air and by the use of a dip tube about three times a day, withdrawing the water in this and allowing it to fall gently in the center of the spawn, thus replacing carbon dioxide with oxygen and dislodging any sediment which may have settled there.

It is not always easy to distinguish the sexes of Cichlids. During the mating season they assume darker colors and appear entirely different. The males commonly are larger and more colorful and their dorsal and anal fins are pointed, while those of the females are somewhat rounded.

521. What is the disposition of the Cichlids?

All Cichlids of the genus *Pterophyllum* can be kept with other fishes, but except for this genus, most members of this family are bad-tempered and untrustworthy in a community tank. Only young specimens can safely be placed with other fishes, and even these may require watching. A few dwarf Cichlids introduced into North America during 1934 have proved better natured than most and do not molest fishes of other kinds, but invariably when the time arrives for breeding these temperamental beauties, it is wise to give them a separate aquarium, and they require a quiet location, free from disturbance.

If allowed plenty of room, young Cichlids can be kept together and will grow rapidly if supplied with abundant food.

522. Why do the eggs of some species of Cichlids turn white?

White eggs are dead eggs, due to sudden changes of temperature or because they are not fertilized. Mated pairs are necessary for the production of fertile eggs.

JEWEL FISH, CHANCHITO, ACARAS, SCALARE, JACK DEMPSEY,
MOUTHBREEDERS AND OTHERS

(FAMILY CICHLIDÆ)

523. What are the range and habitat of the African Jewel Fish, *Hemichromis bimaculatus*?

It ranges from the upper Nile south to the Congo River and is found in the subterranean waters of the Sahara Desert. It is called also Jewel Fish and Red Chromide.

524. What are the normal and breeding colors of the African Jewel Fish?

The body is olivaceous to reddish brown, shading into a purplish crimson in the ventral region. Three black spots are present, one on the gill cover, one in the middle of the side, and another smaller one at the base of the caudal, though this is not always visible. At breeding time the beautiful colors are heightened and the body appears as though sprinkled with gems. The male becomes dark golden brown with a deep red sheen, his gill covers, sides and fins dotted with rows of bright-turquoise blue spots, while

his ventral region assumes a bright crimson. The female resembles him but her colors are lighter, her spots less numerous, and the tips of her anal and dorsal fins are more rounded. Also, she becomes rotund with ripe ova.

The average length of this species is three inches, maximum six.

525. What are the breeding habits and requirements of the African Jewel Fish?

A breeding tank of 10 gallons' capacity is best, though Mr. Lanier has reared many Jewel Fishes in eight gallon aquaria. If possible, it is well to place the breeding tank where it will receive a little sunlight and where the adults will not be disturbed. Sometimes, if alarmed, they eat the eggs and may do away with the young. Fine gravel or coarse sand should be provided and the aquarium well planted with *Vallisneria*, *Anacharis* and *Sagittaria*. It is advisable to slope the sand toward the front and set the plants along the back and ends of the tank, where they are not as easily uprooted.

Previous to spawning, the pair choose a spawning place and carefully clear its surface of silt or other debris. A flat stone or small flower pot is acceptable for this purpose. The female deposits her eggs in single layers on the stone or on the pot inside or outside. The male follows her, casting his milt upon them. This procedure continues until from 100 to 300 or more eggs have been laid and fertilized. After the spawning, both parents take turns in guarding and fanning the eggs with their pectorals and tails. Dead eggs and debris are promptly removed. The usual hatching period is from two to four days, depending upon the temperature. The warmer the water, the sooner they hatch. When the young are about to emerge, the parents carry them in their mouths to previously prepared hollows scooped in the sand, usually near the vegetation, and guard them continuously, sometimes moving them many times to new depressions until they are able to swim. In about a week, when the yolk sac is almost completely absorbed, the young are ready to eat. Their first food should be given at least four times a day, and six times is better. They will take newly hatched brine shrimps on the first day, and on such a fare grow twice as fast. For those who cannot feed with brine shrimps, infusoria, rotifers and screened *Daphnia* may be substituted. As they grow older, white worms, scraped beef and chopped earthworms are suitable.

The adults take almost any fish food, but prefer live food.

The temperature of the water should be 75° generally, raised to 80° for spawning.

526. What are the characteristics of the African Jewel Fishes?

They are hardy and usually prove devoted parents, but they are temperamental and also as a rule pugnacious. They have survived for five years in captivity.

527. What are the range and habitat of the Orange Chromide, *Etroplus maculatus*?

It is found in fresh and brackish waters along the coast of Madras, India.

528. What are the colors and breeding habits of the Orange Chromide?

This is a colorful species. The body is a golden orange, dark olivaceous on the back, and silvery in the ventral region. Three round black spots grace the side and numerous red and golden dots and lines also are present. The colors are more vivid during the breeding period. Dorsal and anal fins are light golden brown, marked with brown and reddish shades and edged with black. The ventrals are almost black, the caudal light orange and pectorals lighter.

The average length is three inches.

This species can be propagated in a manner similar to that described for the African Jewel Fish. A dozen or more eggs are deposited on stones, sometimes on plants, until from 150 to 250 have been laid, over a period of from one and one-half to two hours.

The foods of this species are the same as those of the African Jewel Fish, also the water temperatures. (No. 525.)

529. What are the characteristics of the Orange Chromide?

Like most Cichlids, it will bear watching, though it is not as pugnacious as some members of its tribe. Under proper conditions, it will survive for nearly three years in the aquarium.

530. What is the habitat of the Sheepshead Acara, *Æquidens curviceps*?

The Amazon Basin. It was formerly known as *Acara thayeri*.

531. What are the colors and breeding habits of the Sheepshead Acara or *curviceps*?

The body is light bluish green and shades to a light brown toward the head. The belly is light cream and has a rosy sheen.

The back is dark olivaceous. A dark stripe extends from the eye to a dark spot near the middle of the body. The caudal fin, also the posterior section of the dorsal and anal, are a bright yellow to orange, spotted with bluish green. The ventrals are light yellowish green. It is difficult to give an exact color description of this fish which, like most other Cichlids, is subject to color changes.

The average length is nearly four inches.

This Cichlid is not easily propagated and even if you succeed in getting a mated pair, they usually dispose of their first few spawnings.

Select a quiet location, free from disturbance, and treat them in the same manner as the African Jewel Fish, except that the water temperature should be 78° generally, 84° for spawning.

532. What are the characteristics of the *curviceps*?

A peaceable, temperamental species, it gets on with other fishes of equal size, and does not destroy aquatic plants. It will survive three or four years in the home aquarium.

533. What are the range and habitat of the Blue *Acara*, *Æquidens latifrons* (formerly known as *Acara pulchra*)?

It ranges from Panama through Colombia, Venezuela and Ecuador and is found also in the island of Trinidad, where it frequents drains, water holes, swamps and rice fields. In Trinidad it is known as the Small Coscorob.

534. What are the normal and breeding colors of the Blue *Acara*?

The body varies from bright green or light yellow to a brownish hue with a number of more or less well defined dark vertical bands on the sides. Each scale has a small blue spot which gives a shining blue effect to the sides. The gill covers are blue to blue green, marked with darker stripes. Dorsal, anal and caudal fins are reddish brown with light bluish green spots, and the dorsal and anal are edged with reddish brown. The colors of the male are much brighter during the breeding period. Both sexes at this time show the vertical barring more distinctly, especially the female, which also has more pointed fins.

The average length is four inches, maximum six.

535. What are the breeding habits of the Blue *Acara*?

This species has been known to deposit its spawn in a depression on the bottom of the aquarium formed by fanning away the

gravel with its fins; also, it can be propagated in the same manner as is the African Jewel Fish. (No. 525.)

Blue *Acaras* in the wild state are very devoted parents. Mr. Guppy states that sometimes 100 young may be observed moving about under the body of the parent and when any other fish attempts to snatch one, it is viciously snapped at. In captivity one may find an occasional exception to this parental constancy, which necessitates removing the eggs or young to save them. From 200 to 300 or more eggs have been counted.

The temperature of the water should be 72° generally, raised to 80° for breeding.

This *Acara* is fond of scraped beef, garden worms, chopped clams, some prepared foods, and fresh-water shrimps. Also, it is partial to mosquito larvæ.

536. What are the characteristics of the Blue *Acara*?

It is not to be trusted with smaller fishes, but is very handy and easy to propagate, and will last for upwards of five years under domestication.

537. What is the range of the Brown *Acara*, *Æquidens portalegrensis*?

It ranges from southern Brazil northward to Paraguay and Bolivia.

538. What are the colors and breeding habits of the Brown *Acara*?

Often it is greenish to brassy brown, sometimes showing a yellowish sheen, but the colors vary greatly and the body may appear blue. Numerous vertical dark bars appear on the sides and one black spot in the middle of the body. Each scale is edged with black. A dark band extends from the eye to the base of the caudal, terminating in another black spot. The dorsal, anal and caudal fins are a reddish brown, reflecting a brassy sheen. The horizontal bands are more pronounced and the body color lighter during the mating season.

The average length is four inches, maximum five.

The breeding habits are similar to those of the African Jewel Fish. This species is propagated without difficulty and it is a pretty sight to witness a devoted pair guarding several hundred youngsters. The eggs hatch in three or four days and are protected and fanned by the parents.

Water temperature should be 75° generally, 80° for spawning, and the foods are the same as those of the Blue *Acara*. (No. 535.)

539. What are the characteristics of the Brown *Acaras*?

They are not as pugnacious as most Cichlids. Individuals have a tendency to rush at one another when a number are kept together, but this seems more a matter of playfulness than fighting.

This species sometimes is confused with the *latifrons* or Blue *Acara*, which it resembles closely; but the dark band across the body of *portalegrensis* is a distinguishing mark, and the blue is less dominant.

The record of survival for this species in captivity is six years.

540. What is the habitat of the Dwarf Yellow Cichlid, *Aistogramma pertense*?

The Amazon Basin.

541. What are the colors and spawning habits of the Dwarf Yellow Cichlid?

This is a very beautiful fish. The upper part of the body is light olivaceous to light buff. The ventral region is grayish silver and the sides reflect a bluish netted pattern. Sometimes a well defined but broken black lateral band extends from the nose through the eye to the caudal base, where it ends in a black spot. All the fins are light grayish to orange. A small black stripe extends from the eye to the lower portion of the gill opening. The gill covers are orange with bluish green markings. The first rays of the dorsal and ventral fins are edged with black. The colors are more vivid during the breeding period. The dorsal and anal fins are rounded in the female, long and pointed in the male. Males measure about two and one-quarter inches, females one inch less.

The breeding habits are similar to those of the larger Cichlids, but fishes of this species are not prolific and a large tank is not necessary. They always try to deposit their eggs on the under side of a flat stone or a shell, out of sight, and one needs to watch closely to discover them. Sometimes they will eat the eggs, and if it is desired to propagate them it is best to remove the adults as soon as the eggs are seen. Out of six spawnings, Mr. Lanier saved only two eggs, the others having been eaten by the parents. The young are not difficult to raise, however.

Water temperatures should be 75° generally, 80° for spawning, and the foods are the same as for the Blue *Acara* (No. 535).

542. What are the characteristics of the Dwarf Yellow Cichlids?

They are peaceable and do not uproot the plants like most other Cichlids. They may last only a little more than one year, however.

543. What is the habitat of the Peacock-Eye Cichlid (*Astrototus ocellatus*)?

It ranges through Central South America in the Amazon and its tributaries.

544. What are the colors and habits of the Peacock-Eye Cichlid?

The typically Cichlid, compressed body, presents a piebald appearance at times, particularly in young specimens, with heavy mottlings of rich brown or black over a pale yellow background, sometimes interspersed with scarlet spots. The name of Peacock-Eye derives from the ocellus at the base of the caudal fin, which consists of a narrow scarlet ring surrounding a nearly round black spot. Other ocelli may be present along the upper line of the body. The front of the dorsal and anal fins is spinous, and the soft posterior portion of these fins is large and black like the tail. The scarlet of the caudal ocellus is matched by dots of the same color around the gill covers and at the rear of the large black eye.

This species has not bred in captivity.

It is one of the Cichlids which grows large (10 or 12 inches maximum length) and cannot be trusted with smaller fishes, which it approaches in a most placid manner and calmly engulfs.

Mrs. Willard H. Wright of New York, relating her experience with a pair which she attempted to maintain in a community tank, says that when she acquired them they were only one and one-quarter inches long, but the male grew rapidly and by the time he had doubled his length he had made off with two male Guppies and one male *Girardinus*, and one morning when she looked into the tank he was standing on his head with what appeared to be blood dripping from his distended jaws. It turned out to be the tail of a large Bloodfin which he was slowly swallowing. It took several hours for the tail to disappear. (This is a trick of the Black Bass, which swallows large fishes that sometimes take three or four days to go down.) Mrs. Wright likens the piebald markings of her young specimens to the markings of the Nassau Grouper, and says these Cichlids were tame from the beginning, feeding from her hand.

They require a temperature of from 75° to 80°.

545. What is the habitat of the Mother of Pearl Cichlid or Brazilian Mud-eater, *Geophagus brasiliensis*?

Southeastern Brazil.

546. What are the colors and spawning habits of the Mother of Pearl Cichlid?

The body is light yellow to gray, reflecting a greenish sheen. Pearly dots cover the gill plates and sides, giving the appearance of eight or more light stripes. Vertical cross bars and shoulder spots are present on the bodies of young individuals and these become less distinct as they mature. Dorsal, anal and caudal fins reflect a reddish brown sheen which is much more vivid during the mating season. The dorsal is edged with black.

Old males can be distinguished by the high forehead, which is not unlike that of the ocean fish called the Dolphin. Fishes of this genus have a large head and the body tapers toward the tail. The average length is nearly five inches, with a maximum of 10.

A large tank, provided with fine clean gravel or sand and a flat stone placed among the plants will be needed to breed this species. The eggs will be deposited on the stone and the male and female assume their care as do other Cichlids. Sometimes one or the other takes full charge and it becomes advisable to remove the aggressor. From 250 to 300 or more eggs may be deposited, and the fry are easily reared.

The temperature of the water generally should be 70°, raised to 80° for spawning.

This Cichlid likes pieces of beef, beef heart, clam and garden worms, and takes also some prepared food.

547. What are the characteristics of the Mother of Pearl Cichlid?

• It is not to be trusted with other fishes, especially with smaller individuals. It is a hardy species and has ~~survived~~ for six years in captivity.

548. What is the habitat of *Geophagus gymnogenys*?

It ranges from Rio Grande do Sul (southern Brazil) to Montevideo (Uruguay).

Geophagus means mud-eater, and *gymnogenys* means naked chin. It is difficult, therefore, to give the fish a common name, and generally it is called by its specific name.

549. What are the colors and breeding habits of *gymnogenys*?

The body is rock brown to deep green, the belly lighter. A large black spot ornaments the side, and the gill covers, scales and fins have pearly greenish dots. The fins are barred and spotted with brown.

The average length is nearly five inches.

The breeding habits are similar to those of the Mother of Pearl Cichlid. (No. 546.) Temperature requirements are 75° generally, 80° for breeding.

Most prepared foods are acceptable, but pieces of meat, fish, mussel and garden worms, and also fresh-water shrimps are appreciated.

This is a pugnacious, vigorous species, very destructive of aquatic plants.

550. What is the habitat of the Chanchito or Brazilian Zebrafish, *Cichlasoma facetum*?

It is found in ponds and slowly moving streams tributary to the Rio de la Plata in South America. As its name indicates, it is common in Brazil.

551. What are the colors and spawning habits of the Chanchito?

The colors are extremely variable. As a rule the body runs from light to dark green or brown. Sometimes about seven vertical bands are visible on the sides. All colors become intensified during the breeding period, when the body may become golden orange, the fins marked with dark red. The English call this species Chameleon-fish because of its remarkable capacity for changing color, a fish gray body sometimes passing through the reds and browns until it is almost black, while the fins may change to orange.

The males usually are larger and their dorsal and anal fins are pointed. Most aquarium specimens average about four and one-half inches but may attain a length of eight inches. This is one of the smallest of the many species of Chanchitos (18 of which are indigenous to Mexico).

Like most of the Cichlids, it spawns on large flat stones, and its requirements are similar to those of the African Jewel Fish. (No. 525.)

The little ones hatch in three or four days and in five or 10 days begin to swim around after their parents in an interesting procession. They are stowed away at night in a nest scooped in the sand. The parents may care for them for two months and even

then may not turn cannibal, but for safety's sake it is as well to remove the fishlets when able to fend for themselves. They breed when about nine months old.

Chanchitos thrive in living-room temperature, which, for breeding, should be raised to 80°. They are hardy; neither male nor female can be trusted with other species, as they are great fighters; also they uproot vegetation, hence the name Chanchito, meaning pig. They will live for upwards of four years in the home aquarium, are carnivorous and subsist upon worms and other small aquatic animals in a state of nature. In the aquarium they accept almost any food offered, but appreciate live food.

552. What is the habitat of the Mesonauta, Pretty Cichlid or Flag Cichlid, *Cichlasoma festivum*?

It inhabits northern South America and is indigenous to the Guianas, the Amazon River, and the great estuary of the Rio de la Plata. Formerly it was called *Mesonauta insignis*.

553. What are the colors of the Flag Cichlid?

The almost round body is yellowish to green, with a wide black stripe running from the mouth through the eyes to the posterior tip of the dorsal fin. A black spot, surrounded with light green, lies on the caudal peduncle. Indistinct wavy bands cross the body. The fins are light yellow with golden brown and white spots, and the tips of the trailing filaments of the ventrals are golden orange. These sometimes reach beyond the tail. The iris is brassy yellow.

The average length is six inches.

Spawning habits are similar to those of the African Jewel Fish (No. 525), but it is not a prolific species and rarely is propagated.

The temperature of the water generally should be 75°, 80° for spawning.

This is a vigorous and pugnacious fish, which will survive for more than five years in captivity.

It takes almost any food offered.

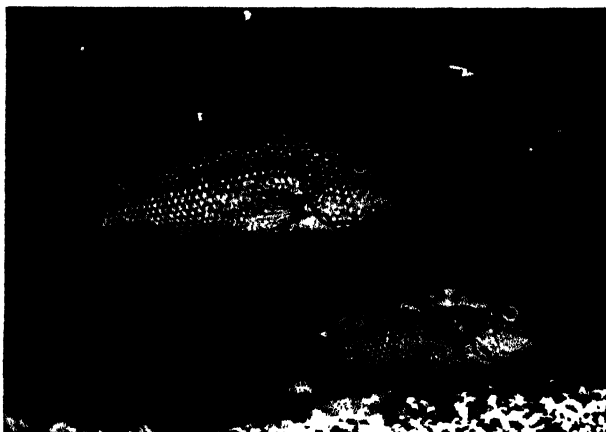
554. What is the habitat of the Jack Dempsey, *Cichlasoma biocellatum*?

This is an Amazon species.

555. What are the colors and breeding habits of the Jack Dempsey?

It varies greatly in color from light fish green to dark green or both sexes have six vertical bands on the sides, and a dark

stripe extends from the eyes through the center of the body, forming a black spot which lies on a lighter background on the shoulders, and terminating in a similar spot at the base of the caudal fin. The lower lip is blue green and similar numerous spots adorn the gill covers. The posterior section of each scale is colored likewise. During the mating season the bands disappear, the colors of the male are much more vivid, the body changes to a deep velvety black and the blue green spots gleam like jewels over body and fins. The



Courtesy John G. Shedd Aquarium

The Jack Dempsey is pugnacious, a plant destroyer, and prefers live minnows for its fare; but it is handsome, prolific, easily propagated, and will survive for upwards of eight years in captivity. The specks at the lower left in the picture are fry, swimming with their parents.

dorsal and anal fins, also the ventrals, are edged with red. The female lacks the intense colors of the male and her dorsal and anal fins are neither as long nor as pointed.

The length attained is seven inches.

The breeding habits resemble those of the African Jewel Fish (No. 525.) This species is prolific and propagated without difficulty in a large aquarium. Like many other Cichlids, it will eat the spawn, and if disturbed may swallow the fry also.

Water temperatures generally should be about 75°, and for breeding, 80°.

This is a very hardy, pugnacious fish, carnivorous and an uprooter of plants. It will live for upwards of eight years under suitable conditions. Its preference is for Minnows, fresh-water shrimp.

earthworms, Daphnia, in fact any live food offered, but it takes also cut beef and fish. The young will accept prepared foods.

556. How is the Jack Dempsey distinguished from the Chan-chito?

The Jack Dempsey is distinguished by the dark stripe extending from the eye to the base of the caudal, and the black shoulder and caudal spots; also by the bluish green gill covers and lower lip, and the red border on dorsal and anal fins.

557. What is the habitat of the Sedate Cichlid, *Cichlasoma severum*?

It is found in British Guiana and Brazil, in the Amazon and its tributaries.

558. What are the colors and breeding habits of the Sedate Cichlid?

The color varies greatly. It may be yellowish, olivaceous, light golden brown or almost black with bluish gray or green predominating. A number of vertical bands mark the sides of younger specimens, but usually are indistinct in the adults except for two bands, one which joins the posterior bases of the dorsal and anal fins and ends in a round spot on each fin, and one lying at the base of the caudal. The dorsal and anal fins are greenish yellow to dark brown, edged with red and violet. The ventral fins run from light golden brown to near black. The forward part of the body bears irregular dark markings and a number of reddish spots form definite lines.

The breeding habits resemble those of the African Jewel Fish, except that a larger tank—about 12 gallons' capacity—is better for propagating this species. The eggs hatch in about four days and the young become free swimming in another four or five days. Water temperatures are the same as for the African Jewel Fish. (See No. 525.)

This species reaches a length of eight inches, though most specimens average about five.

The foods preferred are strips of beef and fish, garden worms, fresh-water shrimps, brine shrimps and other live foods. The young will take prepared foods.

This Cichlid is not as pugnacious as some others, but will sometimes uproot plants. It is a hardy aquarium species and has lasted more than 10 years under domestication.

559. What are the range and habitat of the Black-banded Chromide or Black Cichlid, *Cichlasoma nigrofasciatum*?

This species ranges from Mexico south through Central America. It is abundant in the volcanic lakes Amatitlan and Atitlan in Guatemala, where it lives near the shore among the larger plants.

560. What are the colors and breeding habits of the Black-banded Chromide?

The steel colored body is tinted with lavender and barred with rock brown. The fins of the posterior half of the body are grass green, sometimes ruby, and in older males the dorsal and anal fins are proliferated into trailing filaments. In the breeding season the male sometimes is dressed in a coat of deep black offset with turquoise gems, and his pectorals become suffused with red. Usually eight black bands are noticeable, sometimes turning faint as the body assumes a grayish tinge.

A maximum length of six inches is reached, but most aquarium specimens are smaller.

This species breeds in the same manner as the African Jewel Fish and the same preparations will be necessary, also the same care of the fry, which can swim in about five days after hatching and are easy to rear. (See No. 525.)

The temperature of the water for breeding should be 78°, otherwise 70° is suitable.

561. What are some facts about the Black-banded Chromide?

In the absence of something better it is used for food by people who live near Lake Atitlan, but is full of bones and scorned by other folks.

The disposition of this species is ferocious. It is omnivorous, subsisting on small plants and animals. It likes live foods but takes scraped beef, and the fry will eat prepared baby fish foods. It has survived more than five years in captivity.

562. What is the habitat of Cutter's Cichlid, *Cichlasoma cutleri*?

Central America, notably British Honduras.

563. What are the colors and breeding habits of Cutter's Cichlid?

As in most of the Cichlids, the color varies greatly. The body runs from fish green to greenish blue, and the ventral region is dusky yellow in males and young specimens, while in breeding females it

is bluish green to near black. Seven vertical black bands, somewhat regularly spaced, extend from the dorsal fin to the ventral area. A black band extends from the eye to the mouth, and a black splotch adorns the caudal base. Pectoral and ventral fins are light orange, the other fins are reddish, and the anal is edged with dark brown. The iris is bluish green and in certain lights appears golden.

The male averages three inches, the female only two and one-half.

Like most other Cichlids, it selects a dark spot for spawning. From 50 to 100 or more eggs are deposited on stones, flower pots or other flat surfaces. They hatch in two or three days and the parents protect the fry, transferring them from one previously scooped nest to another until they are about four or five days old, when they can swim. The same treatment should be given them as is recommended in the case of the African Jewel Fish, and the water temperatures should be the same. (See No. 525.)

The young will take prepared foods. The adults like scraped beef, also Daphnia, white worms and other live foods.

This Cichlid is not as pugnacious as some others of its tribe, and appears quite hardy. It will survive for upwards of two and one-half years in captivity.

564. What is the habitat of the Golden Cichlid, *Cichlasoma aureum*?

Southeastern Brazil.

565. What are the colors and breeding habits of the Golden Cichlid?

The body is golden orange in color, or light brown, with a greenish sheen. At times three dark spots appear on the sides, and usually there are five or six dark indistinct vertical bands. The ventral region is yellowish. Opalescent spots adorn body and fins, the latter being silvery to light yellow, and the dorsal and caudal have a reddish edge. Adult males have more pointed dorsal and anal fins, and are more brilliantly colored.

The maximum length is 10 inches, most specimens averaging about five. Males are larger in this species.

This Cichlid is not difficult to breed, but, as in the case of other members of this group, it is not always easy to get a pair to mate. Eggs are deposited on flat stones in a secluded place and fanned by the parents, and when the fry hatch, in two or three days, they are moved about, Cichlid fashion, to previously dug pits.

Sometimes the female assumes full charge, and it is advisable to remove her mate.

Though this is a fairly peaceable Cichlid, it is well not to place it with smaller fishes.

It will survive for five years or longer in captivity.

566. What is the habitat of the Red-breasted Cichlid, *Cichlasoma meeki*?

This Cichlid, called also Yucatan Cichlid, is found in lakes and rivers on the Pacific slope of Central America, particularly in Salvador.

567. What are the color and habits of the Red-breasted Cichlid?

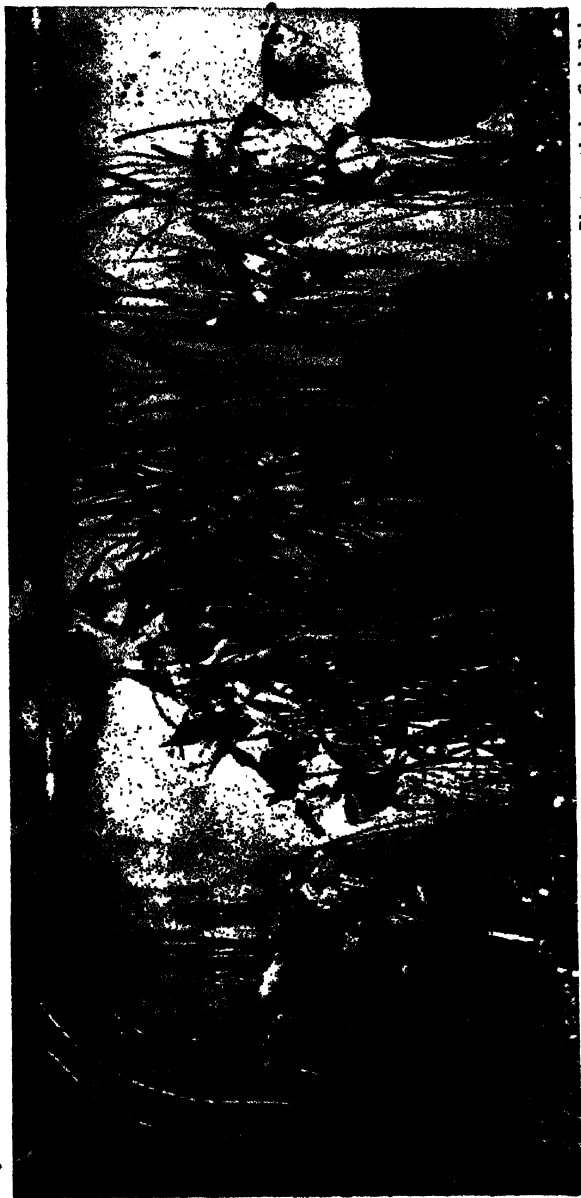
The body is gray or light olive green, with six dark wide vertical cross bands and one short lateral band which extends from the eye to the third vertical band. The mouth, chin, lower part of gill covers and belly are bright reddish salmon, which fades into the ventral and anal fins. These fins are spotted with red and edged with red or brown. The pectoral fins are dusky and have no markings. The dorsal is dusky and streaked with bluish green, the tips of its rays being reddish brown or red. The gill covers have one black spot at their lower edge and are streaked with blue. Another black spot lies at the base of the caudal fin. A bright area back of the pectorals is formed of numerous golden yellow scales. The eye is black, with a ring of bright blue.

This is one of the more desirable Cichlids because of its mild nature. Two pairs may be kept in the same tank and each will breed and care for its own family without warring upon the other pair. This Cichlid will also live peaceably with Moonfishes and other species. The breeding habits are similar to those of the African Jewel Fish, and the foods and general requirements are the same. (See No. 525.)

568. What is the habitat of the scalare or Brazilian Half Moon, *Pterophyllum scalare*?

This species, called also Fresh-water Angel Fish, and Ladder Fish, is taken in northern Brazil, Guiana and Venezuela, in the Amazon, Essequibo and other rivers. The name Half Moon refers to the outline of the fins and not the body. *Scalare* is from *scalaris*, a ladder, and alludes to the banded body and fins, evenly marked off like the rungs of a ladder.

Another species, *P. cimekci*, now is reared in the United States.



Photograph by Carl Rabe

The *scalare* tank at the Steinhart Aquarium, showing at the extreme left *Anacharis*, with *Vallisneria* beside it and at the center right. Center left: *Cryptocoryne griffithii*. In this 65 gallon tank the *Cryptocoryne* plant which four years ago had six leaves, now covers an area 18 inches in diameter and many cuttings have been taken from it for planting in other tanks. It is growing in soil covered with fine gravel. The large *scalare* at the center right has lived in alkaline water for more than 10 years.

in even larger numbers than the *scalare* and frequently is miscalled by the latter's name.

A third species not often available is *P. altum*.

566. What are the colors of *P. scalare*?

The back is olivaceous and the compressed body silvery. Six or seven wide black vertical stripes which adorn the sides terminate in the large dorsal and anal fins. These stripes vary in intensity and at times almost disappear. The body and saillike fins reflect a beautiful violet sheen. The long rays of the ventral fins are bluish white to light yellow and sometimes extend beyond the long anal fin. The pectorals are transparent.

Sexes are difficult to distinguish, but the female is a trifle more highly colored and all the filaments of the male's fins are longer.

570. What are the breeding habits and requirements of the *scalare*?

It has been known to breed in its second and third years. A tank of from 25 to 50 gallons' capacity should be used, well planted with *Sagittaria*, *Cryptocoryne* or *Vallisneria*. Just before they are ready to spawn, the fishes will be observed carefully cleaning the surface of the leaves on which the eggs are to be deposited. Then the blunt ovipositor of the female becomes apparent and is used to place her eggs on the selected leaf, the male distributing his milt over them from a shorter and more pointed organ. The fry hatch in about three days at a temperature of 82°. As a rule the *scalare* do not eat their eggs and the typical Cichlid care which the parents give their young is hard to miss; nevertheless, for safety's sake it sometimes is advisable to remove the leaf to another tank, using the same water in which the eggs were laid and supplying compressed air. There may be 400 or more eggs at one spawning.

One pair observed by Mr. Lanier spawned in alkaline water (pH 7.6) at a temperature of 76°. The tank, which was of 156 gallons' capacity, contained 15 *scalares*. The breeding pair were successfully screened from the others, and after transference of the eggs they were removed to a 35 gallon aquarium, where they spawned again 21 days later.

Scalares generally are kept at a water temperature of about 76°, and this is raised to 85° for spawning.

The fry need to be fed when about to become free swimming, four days after they emerge from the eggs. At this stage infusoria, rotifers, and, when procurable, newly hatched brine shrimps are the best foods and should be given every three hours at least. When

the fry have been free swimming for two weeks, strained *Daphnia* may be supplied, also very small brine shrimps. The fry assume the adult shape in four weeks.

571. What are some interesting facts about the *scalare*?

It is a graceful, not to say majestic little fish, the aristocrat of the pigmies, with a mild nature and a robust physique.

For many years *scalares* were reared only in Germany and shipped to the United States. Many people who now buy "home grown" *scalares* for 25 cents are not aware that imported *scalares* the size of a silver quarter formerly sold for \$12.50 each. At that time the *chaetodon* was called "the poor man's *scalare*."

The maximum body length is six inches, the depth over five inches. From the tip of the dorsal fin to the tip of the anal fin, the spread is nearly 12 inches.

572. What are the natural and artificial foods of the *scalare*?

This species is omnivorous, subsisting on both plant and animal life—insects, beetles, worms and fish fry, also *Riccia*, *Salvinia* and other floating plants.

In captivity, prepared foods are accepted, also canned shrimp and scraped beef. Live *Daphnia*, brine shrimps, white worms, fresh-water shrimps and mosquito larvæ are relished, also small floating plants.

573. How long will the *scalare* survive in captivity?

One has lived in the Steinhart Aquarium for over 10 years. Although the popular belief is that *scalares* prefer slightly acid water, this specimen has lived happily all these years in an alkaline medium.

574. How are *P. scalare*, *P. eimekei* and *P. altum* distinguished from one another?

The fin formations and colors are nearly similar in these three species, but obvious differences exist in the shape of the body and the profile of the head.

The body of *P. eimekei* is longer than high and the curve of the forehead is gentle, i. e., it lacks the angle noticeable in the others.

The body of *P. altum* is higher than long, and the profile of the head shows a deep indentation where the top of the snout meets the forehead.

The *scalare* attains a much larger size than the *eimekei*, its al-

most round body sometimes measuring six inches in length, and the indentation in the profile of its head is not as deep as that of *P. altum*.

575. What special care do the *P. eimekei* and *P. altum* require?

The habits and foods are about the same for all *Picrophyllum* species. Mr. Lanier has bred *eimekei* in alkaline water (pH 7.6).

576. At what age do *P. scalare* and *P. eimekei* breed?

The *scalare* do not breed until after they reach their second year. The *eimekei* will breed in their first year and usually spawn again about three weeks later. A pair in the Steinhart Aquarium spawned 19 days after their first batch of eggs had been laid. This species is more easily propagated than *scalare*.

577. What is the habitat of the Disc-shaped Cichlid, *Symphysodon discus*?

This species, usually called by its generic name, is indigenous to the Amazon.

578. What are the colors and breeding habits of the Disc-shaped Cichlid?

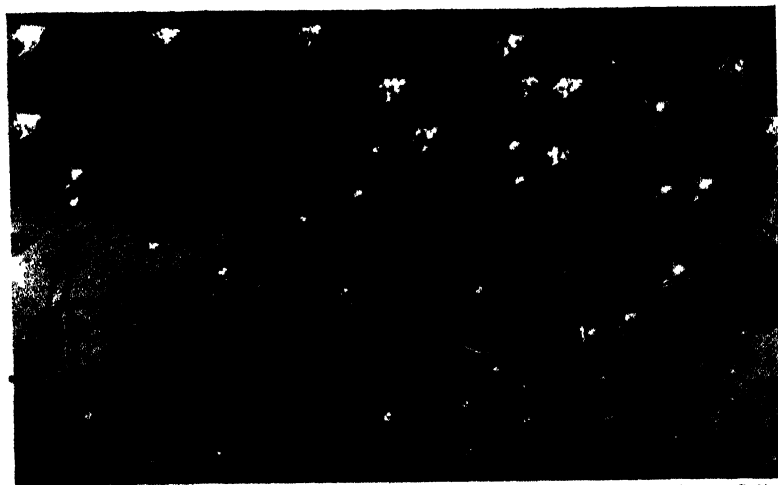
The colors vary, but commonly present a green or brownish green appearance, with numerous vertical bars. The pectorals and ventrals are small, but the dorsal and anal fins extend from the front of the body (about on a line with the root of the pectoral) nearly to the caudal base, the dorsal giving one the impression of hair combed pompadour fashion. Steely emerald wavy stripes extend from the snout backward, some reaching nearly to the center of the body, which is strongly compressed. In the female, the central rays of the caudal are shorter.

A successful rearing of this species, accomplished by Mr. Gustav G. Armbruster of Philadelphia, was described in *The Fish Culturist* (June, 1935). We learn that as spawning time drew near the adults changed to a deep chocolate color, their vertical bands becoming jet black, their dorsal fins edged with bright red and their pectorals a brilliant orange red. Spawning occupied about four hours, and both parents fanned the eggs. The pair having spawned and eaten their eggs on a previous occasion, Mr. Armbruster this time took the precaution, after 24 hours, to remove to another tank the slate slab to which the eggs adhered, and so succeeded in saving and rearing 47 of the young.



Photograph by Robert J. Lanier

Pterophyllum eimekei 13 days old. Hatched in water pH 7.6.



Photograph by J. Solini

Pterophyllum eimekei 7 weeks old.

The eggs were amber and smaller than most Cichlid eggs. They hatched in two and one-half days, the yolk sac disappeared two days later, and the black fry fed from the bottom, their first food consisting of animalcules, principally rotifers, sieved through bolting cloth, after which they took screened *Daphnia*. They were hatched at a temperature of 85°, pH 6.8. The water was kept in motion by two aerators. Growth was rapid, and in four weeks the largest measured three-fourths of an inch, the adult shape was assumed, vertical bands appeared, also orange color in the dorsal.

The Disc-shaped Cichlid is a knowing fish, friendly, good-natured and interesting.

It reaches a length of eight inches and a height of about seven inches—more than eight if the fins are included, being nearly circular. It is the fish for those who like "something big enough to see," though many aquarium specimens average no more than four inches.

Mr. C. H. Peters says that even full grown specimens will not harm a Guppy. Mr. Armbruster found that his specimens favored a diet of mosquito larvæ and *Tubifex* worms.

579. Where is the Egyptian Mouthbreeder (*Haplochromis multicolor*) found?

It is recorded only from Egypt.

580. What are the colors and breeding habits of the Egyptian Mouthbreeder?

The body is dark olivaceous with irregular dark brown markings and the scales glow with metallic greens, blues, orange and violet. The anterior tip of the anal fin of the male is red. The dorsal and anal fins are spotted at the base with bright bluish green dots and edged with blue, red, green and a deep golden orange. The dorsal and anal fins are uniformly spotted with orange, blue and green. The female is not so brightly colored. Her jaws and head are larger and her belly yellowish.

The average length is two and one-half inches.

The male alone or both male and female prepare a "nest" for the eggs, Cichlid fashion, consisting of a depression which is formed by fanning the sand away from a selected area with the fins. They then take mouthfuls of sand or gravel, and spitting it away from the nest, dig a depression about three or four inches in diameter and one or more inches deep. The female picks up the eggs and incubates them in her mouth, and either she or the father should be transferred to another tank after her duties have begun, because



Photograph by Robert J. Lanier

A pair of Egyptian Mouthbreeders (*Haplochromis multicolor*). The female (right) has larger jaws and the rear of her dorsal fin is rounded.

he will annoy her, and may cause her to devour the eggs. The fry hatch in from 14 to 17 days and commonly number from 12 to 60, though this depends upon the age of the mother. One specimen in the Steinhart Aquarium laid 97 eggs. The young remain in the mother's mouth two or three days until strong enough to venture forth. She takes no food while caring for eggs and fry and the babies swim back into her mouth for protection. She protects them also by picking them up. Often they prove too tempting, however, and fall a prey to maternal cannibalism, and it is customary to remove the mother four or five days after they first swim out of her mouth. Some aquarists remove her as soon as the young are seen. Water temperature generally should be 75°, raised to 80° for breeding.

The disposition of this species is uneven. As a rule, it will live harmoniously with fishes of its own size, but the male, on occasion, will give the female a "beating up."

Any food offered is accepted, and under proper conditions this species will last three years.

581. What is the habitat of the Large African Mouthbreeder (*Tilapia heudeloti*)?

It is taken along the west coast of Africa.

582. What are the colors and breeding habits of the Large African Mouthbreeder?

The body is steel blue with a brassy sheen, also a number of black spots, and with a silvery belly. During the mating season a

velvety black blotch is visible on the throat, more noticeable in the female, and the colors brighten. The gill covers of the male are shining yellow, those of the female a light rose color.

The average length is five inches, maximum seven.

Like the Egyptian Mouthbreeder, this Cichlid drops its eggs in a pit prepared in advance by both parents; but it is the male who picks them up and carries them in his mouth during incubation, which covers 12 or 14 days, and the fry do not leave the father's mouth until they can swim. He watches over them in the same manner as does the female Egyptian Mouthbreeder over her young. The female should be removed as soon as he picks up the eggs, as she will annoy him and may cause him to devour them. The fry number 20 to 95, and have a number of dark bands on their sides, also a greenish black spot at the base of the dorsal fin. These markings disappear as they mature.

Water temperatures should be the same as for the Egyptian Mouthbreeder.

All foods offered are accepted, and this species is very fond of algæ and soft plants. Under suitable conditions it will thrive for from one to six years. After four years, however, it generally is too large for the home aquarium, and as it molests other fishes and uproots plants, eating their delicate roots, it has not proved popular. Like the following three species of the same genus, it seldom is seen in the fancier's collection: *T. natalensis*, *T. sparmani*, and *T. zilli*.

LIVE-BEARERS

MEXICAN TOP MINNOW, BRACKISH WATER MILLIONS, *LIMIAS*,
GUPPY, MOLLIES, MOONFISHES, SWORDTAILS AND OTHER TOP
MINNOWS

(FAMILY POECILIIDAE)

583. What is the habitat of the Mexican Top Minnow, *Belonesox belizanus*?

Southern Mexico, Yucatan and Guatemala are the home of this minnow, also British Honduras, whose capital is Belize, from which the fish is said to have received its specific name. The generic name is from *belone*, meaning needle, and refers to the long pointed jaws and sharp teeth. Other common names are Live-bearing Pike and Viviparous Pike.

584. What are the colors and breeding habits of the Mexican Top Minnow, *Belonesox*?

The sides of both sexes are clothed in lustrous bronze green, interspersed with irregular horizontal rows of black spots, and a large black spot is present at the beginning of the tail. At night the fish appears banded with black. The eye is large, with a luminous golden iris.

The male averages about four inches, the female five or more. This is the largest of top minnows and eight inch specimens have been recorded.

This species matures in six months but is not easily bred. Miscarriage sometimes occurs. The young are nearly three-fourths of an inch long at birth and fall a prey to their parents unless provided with hiding places. Though among the smallest viviparous species of fishes, this is the largest live-bearer thus far introduced from tropical fresh waters into the home aquariums of North America.

The water temperature generally should be 75°, 80° for breeding.

Under suitable conditions this top minnow will survive for two years.

585. What are the characteristics of the Mexican Top Minnow?

The name of "Pike" relates to its savage nature, not to the family in which it belongs. Its natural foods are small fishes, tadpoles, water insects and snails, and it will devour fishes half its own size, always being ready to make the best possible use of its long, Pikelike, somewhat curved and never-closing jaws beset with strong teeth for tearing flesh and crunching shells. Nevertheless it has enemies, even among aquarium fishes, and the Cichlid, *Crenicichla lepidota*, has been known to destroy it.

Despite its preference for live foods, it will take raw beef heart if cut in thin strips.

586. What is the habitat of *Girardinus metallicus*?

The streams of Cuba.

587. What are the colors and breeding habits of *G. metallicus*?

Both sexes have a series of 16 short yellowish curved markings running vertically from just above the pectoral fins to the base of the caudal. The back is yellowish or fish green, the belly much lighter. All fins are colorless except the dorsal, which shows a black spot at its base.

The male measures nearly two inches, the female about three.

From 40 to 160 living young are produced in each brood, and they are born at short intervals, a few at a time. The parents do not eat their young if they are well fed, but it is advisable to set the tank where it will receive good light and plant it well with *Anacharis*, *Vallisneria*, *Najas* and *Riccia*.

The temperature should be 70° generally, 75° for breeding. At 78° young are produced about once a month.

This is a peaceable little fish, good for the community tank.

It is omnivorous, with a penchant for vegetation. It is satisfied with prepared foods, an occasional treat of live foods, and an abundance of algæ.

588. What are the range and habitat of the Brackish-water Millions, *Pæcilia vivipara*?

The mangrove swamps of Trinidad and eastern South America coastwise from Venezuela to northern Argentina claim this little fish, also Porto Rico, Martinique, Tobago, and the Leeward Islands. According to Mr. Guppy, it is "partial to dirty, grass-grown drains subject to tidal influence, with very foul, black mud." (Bibliography No. 219.) Often it is found with the Guppy.

589. What are the colors and breeding habits of the Brackish-water Millions?

The female, which closely resembles the female Guppy, is plain fish gray except that the edges of her scales are dark and when young she has a black ocellus in front of the dorsal fin, and faint cross bars. The male is not gaudy like the Guppy and differs with locality. In parts of Trinidad, he sometimes glistens with an electric blue iridescence, his dorsal and caudal are decorated with black, red and yellow margins, he possesses cross bars and also, when young, a silver ringed ocellus like that of the female. In other localities his colors run to chrome, golden red, and salmon.

The size differs according to locality. Some waters contain many fishes of this species in which the males are noticeably smaller than the females, and aquarium specimens usually show this peculiarity, females measuring up to three inches and males only half as much. But near the sea, where live food is exceedingly abundant, both sexes may measure three inches.

This species, which is viviparous as its name indicates, begins to breed at about three months of age, and as the females grow larger, they produce heavier batches of young, these not infrequently

numbering as many as 140. In the wild waters, schools of gravid females swim together.

The temperature of the water should be 70° generally, raised to 75° for breeding. However, this fish is accustomed to muddy, brackish water and does best in old, standing aquaria, apparently not objecting to the change to fresh water.

590. What are the characteristics of the Brackish-water Millions?

More active little fishes than Guppies, easily becoming panic stricken, they rush away on the slightest alarm. They live in large schools, like the Guppies. In the aquarium they have proved hardy and good-natured. Like the Guppies they have an insatiable appetite for mosquito larvæ, taking also other small animals, as worms and crustaceans. They are scavengers by nature, but extremely fond of algæ and young plants. In captivity they accept prepared foods, cracker crumbs, toasted bread crumbs, chopped meats, fish and shell-fish, minced earthworms or white worms, brine shrimps and other live crustaceans of small size.

591. What is the habitat of the genus *Micropæcilia*?

Two little fishes of this genus which occasionally reach the home aquariums of America are taken in Brazil. These are *M. paræ* and *M. branneri*. Another, collected in British Guiana, is *M. bifurca*.

592. What are the breeding habits of the *Micropæcilia*?

They are live-bearers, but so far have not been successfully maintained in aquaria, because of their great delicacy.

The females are the larger, reaching one and one-half inches, and the males smaller, measuring one inch.

593. What are the colors and characteristics of the *Micropæcilia*?

They are as pretty as they are frail, with upturned mouths and large fins, usually vertically barred, and rounded caudals.

In *paræ* both sexes have shoulder spots, the male having another spot on his caudal peduncle and a third just above the gonopod. His caudal and large dorsal are vari-colored, with yellows predominating.

In *branneri* the male's dorsal is wing-shaped, his colors blue and gold, and he is altogether a very elegant little creature. A black spot is present on the caudal peduncle in both sexes, surrounded with yellow, or, in the male, with red or green.

594. What is the habitat of the Dwarf *Limia*, *Limia heterandria*?

Santo Domingo.

595. What are the colors and breeding habits of the Dwarf *Limia*?

The body is fish green, varying to light brown in both sexes. On the male's dorsal fin are two dark curved lines edged with deep orange, and he has several dark vertical lines just below his dorsal fin. The female's dorsal and anal are edged with black, and a dark spot is present at the base of her dorsal.

Young are dropped at intervals of five or six weeks.

A water temperature of 78° is suitable.

596. What are the characteristics of the Dwarf *Limia*?

Like all other *Limias*, it is robust and good-natured, trustworthy in the community tank.

The males reach a length of one inch, the females about two inches.

Like others of its genus, this *Limia* is an algæ eater and will take prepared fish foods. Live foods are relished, also.

597. What is the habitat of the Blue *Limia*, *Limia caudofasciata*?

This little fish, called also Blue *Pœcilia* and Blue Live-bearer, comes from Jamaica in the West Indies.

598. What are the colors and breeding habits of the Blue *Limia*?

A metallic blue sheen glitters over the fish green body, interrupted by six or seven dark vertical bands on the posterior portion. The base of the dorsal bears a spot which is dark in the female, yellowish in the male.

The young, frequently numbering less than 50, are produced with monthly regularity.

A water temperature of 70° is suitable generally, raised to 80° for breeding.

The male reaches nearly two inches, the female nearly two and one-half.

Foods and disposition are the same as those of the Dwarf *Limia*.

599. What is the habitat of the Banded *Limia*, *Limia vittata*?

This species inhabits clear streams, ditches and muddy lagoons in Cuba.

600. What are the colors and breeding habits of the Banded *Limia*?

Both sexes are dusky yellow. The female's fins are transparent with a few dark spots, and indistinct small dark spots form horizontal lines on the sides of the body. Her length is nearly four inches. The male's dorsal and caudal fins bear irregular black markings. He measures about two and one-half inches.

At intervals of five or six weeks young are produced in varying numbers of from 50 to 300 or more. If well fed, the parents do not eat the fry, but a well-planted tank is advisable.

The temperature should be 70° generally, 75° for breeding.

The nature is mild, physique robust.

Algæ is an important food item and Goldfish foods are suitable.

601. What is the habitat of the Humpbacked *Limia*, *Limia nigrofasciata*?

This species, also known as the Black-banded *Limia*, is collected in Haiti.

602. What are the colors and breeding habits of the Humpbacked *Limia*?

The body of mature specimens is yellowish with about 10 vertical bands of black. The rounded dorsal and anal fins are marked with black. The female is less brightly colored. Only the male possesses the hump, which develops after his first year.

This *Limia* measures about two inches.

Batches of young are produced every five or six weeks, the number in each varying from eight to 30 or more.

Water temperature should be 70° generally, 80° for breeding.

The characteristics and foods are the same as those of the Dwarf *Limia*.

603. What is the habitat of the Guppy (*Lebistes reticulatus*)?

It is found in Jamaica in the Greater Antilles, and three other islands of the British West Indies—Trinidad, Tobago and Barbados; also in Surinam (Dutch Guiana), Venezuela, and in St. Lucia (Windward Islands).

It is variously known as Belly-fish because the female usually is distended with young, Rainbow-fish because of the spectrum-colored males, Guppy-fish from a distinguished scientist, and Millions because of its immense numbers.

Its principal enemies in the island of Trinidad are a Cichlid called the Mullet (*Cyrtocichla saepealis*), a pugnacious, Pike-like fish which inhabits streams and pools everywhere and is a ruthless destroyer of Guppies, and *Rivulus (Haplochilus) harti*, which swallows whole even large specimens.

604. How is the word Guppy pronounced?

It is pronounced as spelled—the first syllable rhyming with cup (not with coop). In 1868, R. J. Lechmere Guppy, then President of the Scientific Association of Trinidad, presented this fish, together with two other pigmies, *Rivulus harti (micropus)* and *Anableps anableps*, to the British Museum, where Albert K. L. G. Günther named the species *Girardinus guppyi*, hence the common name of Guppy-fish; but another preserved specimen, from Venezuela, had been named *Pæcilia reticulata* in 1859 by Wilhelm K. H. Peters, Professor of Zoology at the University of Berlin, and after 38 years the older name was revived and modernized as *Lebistes reticulatus*, but the little fish always will be called the Guppy.

The name has an exceedingly interesting etymology. To quote from information supplied by Guppy's son, Mr. P. Lechmere Guppy of Trinidad: The Guppys are descended from the family of Guy Pigli of Florence, whom Dante knew and to whose heraldic arms he refers in *Paradiso*. ("Mighty already was the Column Vair." Line 103, Canto XVI.)

On the migration of the family into France, the name became Goupil, and when, on the revocation of the Edict of Nantes, the Goupils were compelled to seek shelter in England, the name was Anglicized into Guppy. Says Mr. Guppy:

"I find that Irishmen and persons who do not speak English are prone to pronounce Guppy in a similar manner to Goupil. The family here and abroad all pronounce the name to rhyme with cup, and my grandfather, who died in Trinidad at the age of 87 and my father also at the age of 80 always used this pronunciation. I have also been to the City of Bristol where the former was born and it is thus pronounced by Bristolians."

605. What are the colors of the Guppy?

The female is plain fish gray, and it is the male which has earned the name of Rainbow. No two males are exactly alike, and rainbows

seem actually to flit before one in aquatic miniature, in a combination of orange, light green, pink, deep purple, pale blue and magenta, with black spots and lines irregularly disbursed, as the males indulge in their tireless occupation of courting the females. The colors are best seen with the light falling over the observer's shoulder. The fry are fish gray like the mother, males not acquiring their colors until about two months old.

Fanciers have taken advantage of variations in form and color among Guppies and by artificial selection have been able to fix certain admired color patterns and to produce new breeds, such as the Swordtail, Lyretail, Speartail, Gold, Blacktail, Lacefail and Sailfin Guppies. Kissel's Lacetail and Bird's Eye Dorsal are examples of the fancier's art in this respect.

606. What size do Guppies attain?

Among aquarium specimens the females usually measure about one and one-half inches, though they may attain to two and one-half inches, and the males measure slightly less than one inch.

607. What are the breeding habits of the Guppy?

The female is attended by several males.

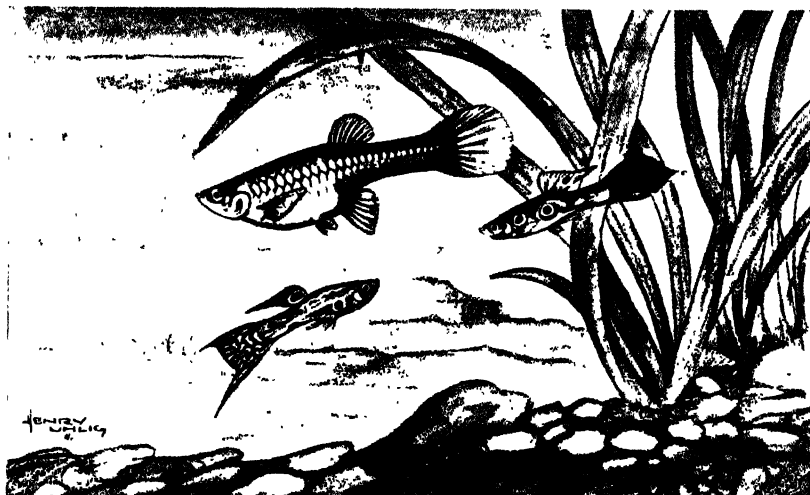
The eggs are fertilized and developed in the ovarian cavity. Guppies breed when about two and one-half to three months old, when about half grown. As a rule the fry number 25 or slightly more at a birth, but older females may produce from 50 to 100 young. In some localities the broods are very small. Mr. Guppy thinks this is due in Trinidad to a habit of moving about in shallow water among the matted, grassy borders of reservoir dams. (Bibliography No. 219.)

One will observe the black "puberty spot" characteristic of mature females of live-bearing species. This is situated just above the anal fin and is due to the accumulation of pigment in the peritoneum near the ovary. The older the fish, the larger the spot and the more swollen it becomes in gravid specimens.

One will notice that the anterior rays of the anal fin of the male are modified into an intromittent organ, or gonopodium, for directing the milt to the puberty spot of the female, where internal fertilization takes place. Differences in structure of the gonopodium occur in different live-bearing species, and it may be fitted with hooks and spines to secure it to the puberty spot during the very brief interval of transfer of the spermatozoa. As in other live-bearing species, females which have been fertilized will bear broods of young over a period of six or eight months without the presence of the males, the sperma-

tozoa of these fishes, like those of the viviparous snails, which also breed indefinitely without the males, being preserved alive within the bodies of the females.

The young at birth measure about 10 mm. and are able to dart away to safety if the means are available. The father nips pieces out of them and the mother swallows them whole. They school the day



Drawn by Henry Uhlig

Guppies

Female (above) with Lyretail male (left) and Blacktail male (right).

Nearly everyone begins with Guppies. At living-room temperature they breed once in three months, much oftener when the water is warmer. The fry number from 25 to 100 at a birth and school the day they are born.

they are born. Males and females ~~are produced in equal numbers~~. Partial sex reversal has been observed among Guppies. (Bibliography No. 178.)

In a thickly planted tank of 15 gallons' capacity it is not necessary to remove the parents. The young appreciate a floating jungle of *Riccia*, or mats of fuzzy plants anywhere in the aquarium, in which to hide, and will eat prepared baby fish foods, powdered yolk of egg, graham or soda cracker dust, oatmeal broth, and juices of meat and shellfish.

Guppies are extremely hardy and will survive in water as cold as 55°, but a temperature of 68° causes them to breed about once

in three months. If this is raised to 73°, they will breed every four weeks.

608. What are the natural and artificial foods of the Guppy?

It is best known in its native waters as a persistent pursuer of mosquito larvæ, and subsists also on tiny crustaceans, aquatic worms, and algæ.

Young and old browse on the algæ of the aquarium. Adults are fond of yolk of hard-boiled egg, chopped fish, meat, shellfish, prepared fish foods, and of course live foods such as *Daphnia*, white worms, brine shrimps, and mosquito larvæ. A common custom is to hang a strip of raw meat in the Guppy tank for a few hours and let them pick at it.

609. What is the disposition of the Guppy?

Except for cannibalism, it is entirely harmless to other fishes, only the tiniest fry being unsafe in its presence.

Guppies are hardy and commonly survive for upwards of three years in the aquarium.

610. What are the range and habitat of the Sailfin, Mudfish, or "Molly" (*Mollienisia latipinna*)?

It ranges from South Carolina to northern Mexico, where it inhabits lowland streams and brackish swamps, ditches and muddy pools.

The generic name is spelled also *Mollienesia* and there are nearly a dozen species of "Mollies" taken in the waters of Mexico, Central America, South America and the West Indies.

This species, along with *Gambusia patruelis*, was introduced successfully into the Hawaiian Islands, where it has proved an effective destroyer of mosquitoes.

611. What are the colors and breeding habits of the Sailfin?

The back is fish green, the sides a deep green, blue black and garnet, with five or six interrupted dark lines running horizontally from gill covers to tail. The long saillike blue dorsal of the male is a much admired appendage, raised to its greatest height when the fish is contented. The females are plainer and lack the "sail." In the breeding season orange tints are added to the head and breast of the male.

The maximum length of five inches is attained in salt water.

The Molly breeds in spring and summer, beginning when about

half grown. It is viviparous, and rather delicate. Females about to bring forth young should not be moved to another tank or disturbed in any way as this may cause premature birth, dead youngsters, and the loss of the mother. The breeding tank should be of at least 10 gallons' capacity. The young are exceptionally large at birth (three-eighths of an inch), and broods are produced from three weeks to three months apart. (See No. 613.) The parents do not eat the babies. The sex can be told from birth by the intromittent organ of the male.

Water temperature should be 68°, raised to 75° for breeding.

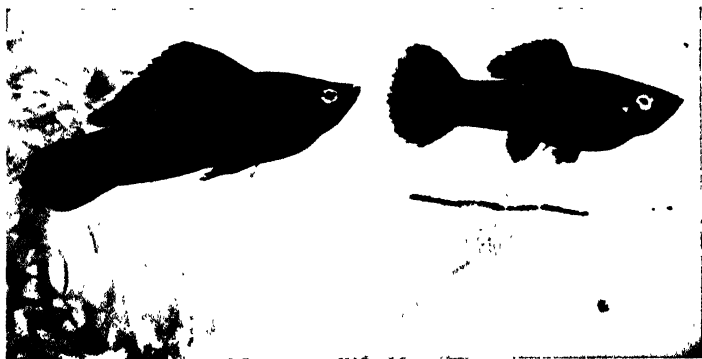
612. What are the interesting characteristics of the Sailfin?

It is a comfortable looking little fish, of friendly disposition, which lives in fresh, brackish, or salt water. It will survive three years in the aquarium.

613. Is the Black Molly another species of Sailfin from *M. latipinna*?

No, it is a color variation of *M. latipinna*, which is sometimes found black or partly black in its natural habitat. From these choice Black Mollies a few breeders have developed a most popular home aquarium fish.

A Black Molly reported by Douglas H. Orrock (*Home Aquarium Bulletin*, May, 1935) produced batches of young at regular intervals of 30 days—about 40 fry in each batch.



Photograph by Edwin H. Perkins

The Black Molly is a color variation of *Mollenisia latipinna*, which sometimes is found black or partly black in its natural habitat. From these choice Black Mollies, a few breeders have developed a most popular fish for the home aquarium.

614. What are the natural and artificial foods of the Sailfin?

Mosquito larvæ, insects and aquatic vegetation, particularly filamentous algæ, form the natural foods. As it is largely herbivorous, it requires a plentiful supply of algæ. The aquarium should be supplied with an abundance of plants and set in a sunny location. Prepared foods and live foods such as wax-worms, mosquito larvæ and brine shrimps are taken, and it is fond of boiled egg yolk, chopped meat, fish and shellfish.

615. What is the habitat of the Giant Sailfin or Giant Yucatan Sailfin, *Mollienisia velifera*?

It comes from Yucatan.

616. What are the colors and breeding habits of the Giant Sailfin?

The sides are bluish green and numerous metallic spots reflect many rainbow tints. The belly and lower jaw are deep orange. The dorsal saillike fin of the male is as long as his body, about one and three-quarter inches in height, and marked with a definite pattern of red, orange, light brown, blue and green, which reflects a lavender sheen. This fin develops slowly, attaining full size when the fish has passed his second year. The female's dorsal is small and her colors plain.

The average length is four inches, maximum six.

The breeding habits and foods are the same as those of the Sailfin Molly. A 10 gallon tank should be provided and located where it will receive at least two hours of sunlight a day. More of the fry will be saved if the tank is well planted with *Anacharis*, *Ludwigia*, *Vallisneria*, and *Crystalwort*. The young are nearly one-half inch long at birth.

The water temperature should be 75° generally, and 80° for breeding.

This Molly has survived for four years in captivity.

617. How is *M. velifera* distinguished from other Mollies?

Usually by its larger, lacy dorsal fin, though a good male specimen of Sailfin Molly may have a dorsal nearly as large and beautiful. Also, it is a larger fish.

618. What are the range and habitat of *Mollienisia sphenops*?

It ranges from Texas south through northern Mexico and in Central America, in lowland streams and brackish estuaries, also in

quite salt water. *M. sphenops cuneata* ranges from southern Texas through Costa Rica and Panama to Colombia, and *M. sphenops vandepolli* is abundant in fresh-water pools in the West Indies and Leeward Islands.

619. What are the colors and breeding habits of *M. sphenops*?

The body color runs from olivaceous to light gray, the ventral region yellowish to bluish white. The male has dark vertical bars alternating with stripes of metallic blue. His dorsal fin usually is edged with light orange, this and his caudal being spotted with dark brown. The sides are marked with horizontal rows of dots.

This species is very variable in size and color. The male averages two and one-half inches, the female three to three and one-half. The large dorsal is not unlike that of the Sailfin.

The water temperature should be 65° generally, raised to about 80° for breeding.

The young, born alive, number from 20 to 35 at a birth. The tank should be set in a sunny location.

The foods are the same as those of the Sailfin. This Molly has lived for three years in captivity.

620. Which fishes are included in the group known as Moonfishes or Platys?

Nearly all these fishes are color variations or breeds of the Blue Platy, or Blue Moonfish, *Platyæcilus maculatus*, which inhabits the waters of southern Mexico and Guatemala, and include the Red Platy, Black Platy, Spotted Platy, Golden Platy, Gold Crescent Platy, Red Crescent Platy and many others. It is an error to call these breeds "varieties," as the Red Platy, "var. *rubra*," Black Platy, "var. *nigra*," Spotted Platy, "var. *pulchra*," and so on.

Forms which have been developed in aquaria are regarded by the Bureau of Fisheries as "without standing in scientific nomenclature." Though named as varieties, they are only variations. (See No. 62.)

The Moctezuma Platy, *P. variatus*, is a distinct species according to Dr. Myron Gordon who brought it from Mexico. Like the Blue Platy, it exhibits a number of color patterns.

621. How have the differently patterned Moonfishes been produced?

These are produced largely by artificial selection, i. e., careful breeding from the most colorful and promising offspring of the parent stock. For example, the Golden Moonfish, which suddenly ap-

peared in a tank of Blue Moonfishes. (Bibliography No. 179.) By careful selection, this spontaneous variation has become a "fixed" variation.

622. How are the sexes of Moonfishes distinguished?

The anal fin of the female is fan-shaped while that of the male is pointed. The female is larger and not as vivid.

Moonfishes reach a length of from one and one-quarter inches to nearly two inches.

623. What are the breeding habits of Moonfishes?

They are live-bearers, and will not eat their young if well fed and the aquarium is provided with surface plants, where the fry may seek safety. Breeding traps are not necessary. The different variations will interbreed, producing many remarkable color combinations. The young in each batch number 18 or 20 and the females remain fertile until four families are born, intervals of many weeks sometimes elapsing between broods.

The temperature for breeding should be 80°, otherwise 72° is suitable.

624. What foods do Moonfishes require?

They are omnivorous and appreciate mixed foods, such as dried shrimp or other prepared foods, fresh chopped fish, clam or mussel, mosquito larvæ, Daphnia, white worms and algæ.

The fry take the finest prepared foods, brine shrimps just hatched, white worms chopped fine, and screened Daphnia.

625. What is the range of the Mexican Swordtail, *Xiphophorus helleri*?

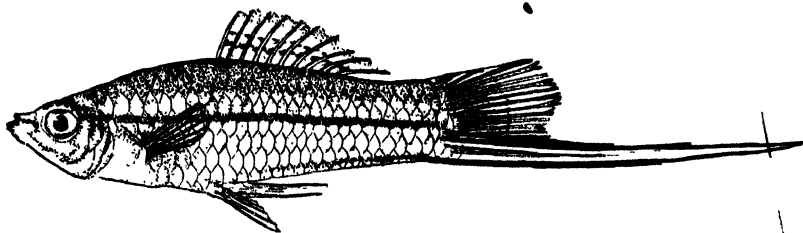
• It is found in lowland streams of Atlantic drainage from southern Mexico to Guatemala.

There are four varieties of *X. helleri*: *X. helleri guntheri* of Guatemalan rivers, *X. helleri strigatus* of the Atlantic slope of southern Mexico, *X. helleri brevis* of British Honduras, and the more familiar *X. helleri rachovii* of the Atlantic slope of Guatemala.

Xiphophorus means sword-carrier. The other names are from people, except *strigatus* which means striped, and *brevis* which means short.

626. What are the colors and breeding habits of the Mexican Swordtail?

The sides often are a metallic blue green with a red lateral stripe and three or more dark vertical bars. The swordlike appendage of the male is yellowish green, sometimes orange or red, but always bordered with black. Colors are varied and the female is less brilliant, but although her shape is similar to that of the female Guppy, she is two or three times as large and much more beautiful, having an orange red lateral band.



Drawn by Toshio Asada

Male Swordtails sometimes measure five inches, including the sword. The young, born alive, may number only eight or over 200. Complete sex reversal from female to male occurs in this species.

The female may measure nearly three inches, the male attaining to five inches including the sword.

These live-bearing fishes reproduce once a month, usually with 40 to 53 young at a birth, though they may number only eight or over 200. The adults are cannibals and unless well fed and kept in a large, well-planted tank, will eat their young. The sword of the male is fully developed in about one year, and sexual maturity is reached by the female in one year, revealed by the "puberty spot" described in the female Guppy. Complete sex reversal from female into male occurs in this species. See Nos. 55, 56.

The water temperature should be between 75° and 80°.

All prepared foods are taken, and live foods are appreciated. Under correct conditions, Swordtails will survive four or five years in captivity.

627. What are some interesting facts about the Mexican Sword-tail?

It received its scientific name from Haeckel, and reached the United States about 1910.

Two males will not get along well together, but if three or more are placed in the aquarium, there usually is no trouble.

Swordtails should not be mated with spotted Moonfishes, though the two genera readily cross breed. Dr. Myron Gordon discovered that:

"When a perfectly healthy black-spotted platyfish is mated to an equally healthy Mexican swordtail killifish, hybrid fishes are born each of which will invariably develop black tumors in various degrees of intensity." *

Dr. Gordon found, singularly enough, that (Bibliography No. 148):

"Neoplastic disease [technically melanosis] in fishes has a definite hereditary basis and appears only in fishes arising from the mating of unlike species."

628. How is *X. helleri* distinguished from *X. helleri* var. *rachovii*?

The latter is smaller, has a black crescent at the base of the tail, and the vertical bars on the sides are more in evidence. The tail is not as long as that of the *helleri*.

629. What is the habitat of the *Montezumæ* Swordtail (*Xiphophorus montezumæ*)?

The basin of the Panuco River in eastern Mexico (northern Vera Cruz and southern Tamaulipas).

630. What are the colors and breeding habits of the *Montezumæ* Swordtail?

The body is a dusky red orange, the back a little darker. The ventral region is grayish silver. The most characteristic feature is a definitely reticulated or chainlike pattern over the body. Along the middle of the sides there are two dark lines where the chainlike patterns meet. There is a very close resemblance, in color pattern, to the *Platyplatys variatus*, especially in the females of both species.

The breeding habits are similar to those of the Mexican Swordtail. From 40 to 150 young may be produced at a birth. The tank should be provided with plenty of aquatic plants to serve as hiding places for the fry.

* Dr. Gordon informs us that this refers to, "any spotted Platy, even a golden spotted Platy," where the spots are irregularly distributed, and "not to the definite crescent moon, one-spot or two-spot marks often seen in Platys."

A water temperature of 75° generally is suitable, 80° for breeding.

Most all foods offered are accepted, and under favorable conditions this species will survive for two and one-half years.

It reaches a length of three and one-half inches.

631. How is *X. montezumæ* distinguished from the so-called "hybrid *Montezumæ*"?

The true *Montezumæ* has small black spots evenly spaced in parallel horizontal lines, while the hybrid has irregular spots that form uneven lines. True *Montezumæ*s are much rarer than the hybrids.

THE FOUR-EYED FISHES

(FAMILY ANABLEPIDÆ)

632. What is the habitat of the Four-eyed Fish, *Anableps dowei*?

The streams of Central America.

633. What are the habits and characteristics of the Four-eyed Fish?

This species is viviparous, bringing forth from 20 to 25 young in a brood, and the length attained is from four to eight inches.

It is regarded as a curiosity because of the peculiar eyes, which enable it to see above and below the surface of the water at the same time. The eyes are crossed by a horizontal bar which appears darker than the eyes and gives the appearance of two pupils, an upper and a lower. When the fish is submerged, the level of the water reaches to this bar so that the upper half of the eyes is above the water, the lower half in the water.

Four-eyed Fishes swim at the surface most of the time, in schools which are arranged in platoons led by one fish. They feed on insects and floating matter. When frightened, they skim over the water or jump, two feet or more at each effort. They are extremely difficult to capture, being able to jump over a seine with ease, though they usually are taken with a tow-net or seine.

The back is light coffee color, and a creamy band, extending from the root of the pectorals to the base of the caudal fin, is edged with a dark stripe below and above. The belly is fish gray. The ventral and anal fins are pale yellow, the other fins dusky.

Mr. H. Walton Clark and Mr. Lanier, while members of the

Crocker Expedition of 1932, succeeded in capturing 18 Four-eyes with a 50 foot minnow seine. They were kept in a wash boiler for over five weeks on the Yacht *Zaca*, and did well despite the very great difficulty in procuring fresh water for them.

(FAMILY HEMIRAMPHIDÆ)

634. What are the range and habitat of the Halfbeak (*Dermogenys pusillus*)?

It lives in the fresh and brackish waters of the Dutch East Indies, Malay Peninsula and Siam.

635. What are the colors and breeding habits of the Halfbeak?

This is not a brightly colored fish. The long cylindrical body is brown or dark fish green, and the ventral regions whitish. The snout is pointed and the upper jaw is about half the length of the lower one. The male has a reddish dorsal fin and his body is smaller and slenderer. He usually measures about one and one-half inches, the female two and one-half inches.

This is a live-bearing species, from two to 20 or more young being born at a time. The adults cannot be trusted with the fry.

A water temperature of 75° is suitable generally, raised to 80° for breeding.

636. What are the characteristics of the Halfbeak?

It snaps at the food sideways at the surface of the water, will take most prepared foods, but is especially fond of live foods.

It will survive about two years in captivity and does not disturb other fishes in a community tank.

637. Does the Halfbeak require salt in the aquarium?

No. Many have been reared to maturity without salt. However, should they lose their equilibrium, add one quart of salt water to each gallon of fresh water and it will soon rectify this condition. (Mix two level tablespoons of salt with a quart of water. This added to the fresh water produces a salinity of approximately 1.016.)

GOLDFISHES

638. To what family of fishes does the Goldfish belong?

The Goldfish is a Carp, *Carassius auratus* (meaning "gilded carp"), and belongs in what is called "the largest natural family of fishes, the Cyprinidae"—Carps, Minnows and Daces. There is only one genus and one species, but since the Chinese began their extensive experiments in artificial variation several hundred years ago, many breeds have been produced, some exceedingly beautiful, some strange and grotesque. The Goldfish descends from the plain dark gray or greenish brown Carp of China, and if artificial selection is discontinued, it reverts to the color and form of the wild ancestral type.

639. Is the Goldfish a native of North America?

The Goldfish is a native of China from whence it has spread all over the world, having been introduced first into Japan, then Europe, America and other countries.

640. When was the fancy Goldfish first known?

According to Ting-Pong Koh, a Chinese writer of distinction, the start of the fancy Goldfish was made with a red-scaled wild fish, *Carassius auratus*, during the T'ang Dynasty, 618-906, in the Chekiang Province of China. Other colors were recorded in the 12th century. The fishes have been cultivated in vessels instead of in ponds since the Ming Dynasty, 1368-1643.

The paired caudal fin appeared in the 16th century, the telescope eye prior to 1619, and the absence of a dorsal fin not later than 1726.

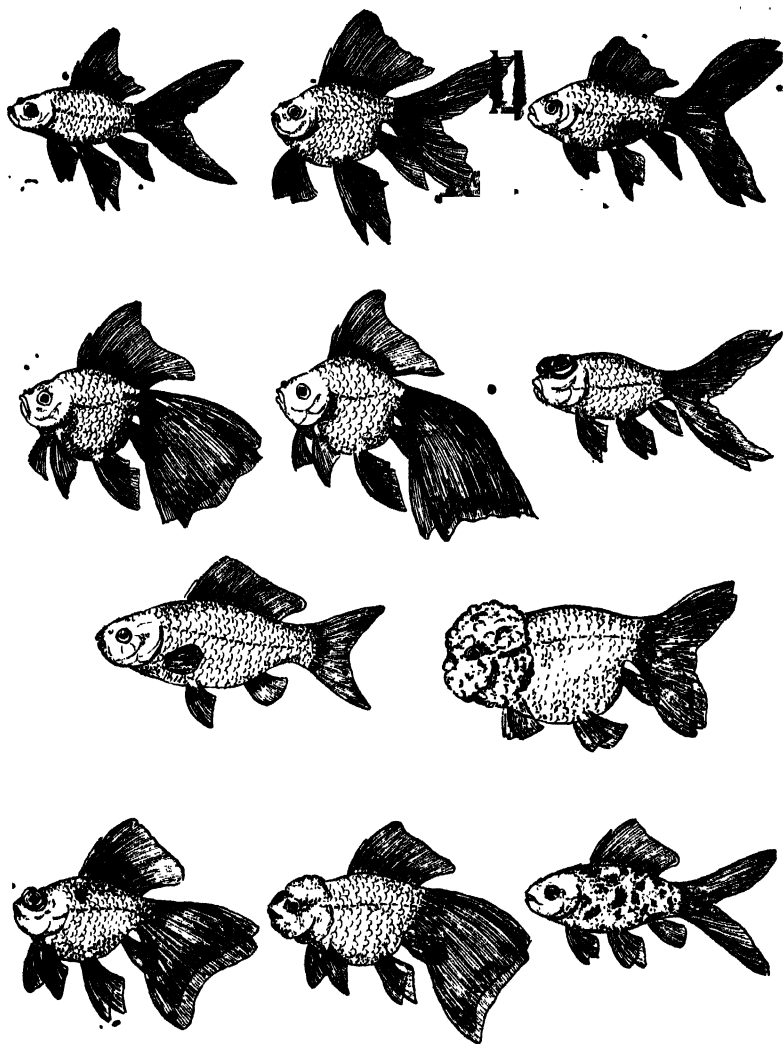
The Lionhead was developed early in the 19th century.

641. When did the Goldfish reach Japan?

According to Mitsukuri, an authority on Japanese Goldfishes, Japan has a record of Goldfishes brought from China in 1500 and later, though the Telescope did not reach Japan until 1895, nor the Celestial until about 1902.

642. When did the Goldfish reach the Occident?

Some say it reached England in 1611, others that it was first sent from China to France as a gift to Madame de Pompadour, some



Drawn by Cyril J. MacMeekin

Goldfishes, though varying so greatly in form and "finnage," are all of one genus and one species, *Carassius auratus*.

Top row, left to right: Comet, Nymph and Fantail. Second row: Veiltail, Fringetail and Celestial. Third row: Common Goldfish and Lionhead. Fourth row: Telescope, Oranda and Shubunkin.

time between 1745 and 1764. It reached America about a century later.

In approximately 1755, New York City boasted at least one pet shop, on lower Broadway, where aquaria were sold as well as Goldfishes and silver fishes (probably American Roach), turtles, pollywogs and feathery plants (probably *Cabomba* and *Myriophyllum*) and a plant resembling *Adwigia*. Our informant, who is 80 years old, says, "I had a rectangular aquarium in those days."

643. What made the Goldfish popular?

Its ready adaptability to changes of water temperature, its brilliant color, and the fact that it does well at living-room temperature, 68° to 72°.*

644. How can one select healthy Goldfishes?

Look the fishes over carefully for perfect fins and the absence of white spots, sunken eyes, and bodies that taper markedly from the rear of the gills to the tail. A healthy fish spreads its tail fin and carries its dorsal fin erect, except under the stress of emotion, and has a full eye projecting slightly beyond the line of the head.

645. How can one distinguish between a Japanese and American Fantail, a Veiltail and a Comet, all of which have long tails?

The Japanese Fantails have short bodies and long flowing tails, whereas the American Fantails have longer bodies and shorter tails, which commonly are held horizontally. The double tails of the Fantails are separated vertically and generally are forked. The tail of the Veiltail is double, more elongated, square, and hangs like a veil. The Comets have slender bodies with large forked tails.

646. Where did the Comet Goldfish originate?

It is believed to have originated in the United States. Hugo Mulertt laid claim to having developed the Comet in 1881 and to having named it after a long-tailed comet seen in American skies that year.

647. What is a Japanese Fringetail Goldfish?

The Fringetail has a short, round body, all the lower fins are paired, the dorsal is long and as high as the body is deep, and the

* All temperatures are Fahrenheit.

double flowing tail may be longer than the fish. The Fringetail with slightly forked tail is called also the Broadtail, but in some specimens the tail is deeply forked and these are called Ribbontails or Swallow-tails.

648. What is a Telescope Goldfish?

Telescopes are those in which the eyes are large. Some are of various colors, occasionally orange, red, white, purple and blue, or may be jet black. Varicolored ones are called Calico Telescopes. Black Telescopes are called Chinese Moors. Telescopes may be Ventrail or Broadtail, scaled or scaleless. Their bodies are short and round, and in richly colored specimens even the eyes are of various hues.

By common assent the handsomest of Goldfishes is the Calico Telescope.

649. What is meant by Nymph?

The Nymph is essentially a single-tailed Fringetail. It is a cross between a Comet and a Fringetail, having the Comet's body and the Fringetail's flowing caudal fin.

650. What is a Shubunkin or Calico Goldfish?

It is of the type of the Common Goldfish, with a strong tail and a body mottled with gold, blue and brown. Some Shubunkins are scaleless. In England a new Shubunkin has been developed, known as the Bristol Shubunkin. Chiefly it differs from the older type in the length and character of the tail, which is three-fifths the body length, forked but very broad and with rounded tips.

651. What is a Celestial Goldfish?

The Celestial has telescope eyes on the top of the head which can look only heavenward. Some Celestials lack the dorsal fin. It is not true that the Chinese develop Celestials by keeping them in dark narrow troughs, compelling them to look up to find the light. Celestials are bred by artificial selection, the same as all other Goldfish oddities. They are not as hardy as other Goldfishes, and rare expertness is required to rear them.

652. What is an Egg-fish?

Koh describes the Egg-fish as "a short-bodied fish with normal eyes and without the dorsal fin." It is like a Lionhead without the hood. These fishes seldom have been seen in America. (Bibliography No. 152.)

653. How have scaleless Goldfishes been produced?

The Scaleless Japanese Fringetail and Scaleless Veiltail Telescope have been bred from Japanese Fringetails and Chinese Scaleless Telescopes. Scales are not absent, but are transparent and difficult to see with the naked eye. Scaleless Veiltails, Comets and Nymphs also have been produced.

654. How are Lionheads and Orandas distinguished?

In both fishes a peculiar excrescence called a "hood" begins to develop at about six months. There are several kinds of Lionheads and in some the hood is limited to the top of the head, in others it surrounds the eyes also. One kind has a long tail. In the Lionhead the dorsal fin is always absent, while in the Oranda it is always present as in most other Goldfishes, and both fins and body are larger than the Lionhead's. In both fishes the caudal fin is double, and both average about six inches in length. The Oranda is a more valuable fish and was produced in Japan about a century ago by crossing the Lionhead with the Fringetail. Calico Lionheads and Orandas now are on the market.

655. What is the value of fancy Goldfishes?

Seventy-five dollars is not an exorbitant price for an Oranda.

As recently as 1929 the sum of \$500 was paid for a blue Telescope Veiltail at a London exhibition of the British Aquarists' Association. Among valuable Goldfishes the record is held by Old Black Joe, owned by Otto Gneiding of New Jersey. The fish, a jet black Moor, was father of a numerous progeny. During the World War he changed to red, white and blue, became known as Miss Liberty, and was used to forward the sale of Liberty Bonds. Old Black Joe was valued at \$5,000 and lived for more than 20 years. (Incidentally, he never heard of pH.)

656. What is a Chinese Moor?

It is the only jet black Goldfish which has been produced. It is called also the Veiltail Moor Telescope because of the character of tail and eyes. The dorsal fin is high, the body round, the scales a rich velvety black. The Chinese Moor does not always remain black for life. Under the microscope the scales show large groups of black color cells and small groups of golden cells, and the fishes may change color at any time, when the black pigment fades.

657. Do Goldfishes change color?

Any Goldfish is likely to revert to its ancestral dark gray or greenish brown, the color of the wild Carp. According to Mitsukuri, during the late summer of their second year, all individuals change their color. See preceding question. (Bull. by No. 222.)

658. What length will a Goldfish attain under normal conditions?

Only the Common Goldfish attains a great length. In this country, Common Goldfishes kept in ponds for breeding purposes have attained a length of two feet.

659. How long do Goldfishes live under normal conditions?

They are known to live for from 25 to 30 years when given ample swimming space, proper food and uncontaminated water. An unusual record for a group of Goldfishes is that in which 65 lived in a 120 gallon tank of running water for 15 years without a fatality. They were fed with dry food daily and new plants were introduced once a year.

660. To what extent does captivity stunt the growth and limit the lives of Goldfishes?

The best record we have is of a Goldfish which lived in a six gallon aquarium for 25 years and measured only four inches when it died; i. e., the length of life may not be interfered with but without free swimming space the growth is radically limited.

661. Is it necessary to cover the Goldfish aquarium?

Goldfishes seldom attempt to leap from running water, but the balanced aquarium should be covered if the more slender bodied Goldfishes occupy it—such as the Common, Shubunkin and Comet. These may jump out. The cover should be set on corks to provide an air space, or a wire cover may be used.

662. On what do Goldfishes subsist in a state of nature?

Goldfishes are called vegetable feeders because they can live exclusively on plant substances, although they take also aquatic worms, insects, snails, small crustaceans and other minute animals. Adults are not cannibalistic. Like most other little fishes, they are fond of mosquito larvæ and make themselves useful in this respect in house ponds.

663. Do Goldfishes eat mosquito larvæ only for the sake of pursuing the prey, or is there some nutriment in this food?

Many years ago a Goldfish enthusiast had mosquito larvæ analyzed to settle this point and then prepared an artificial food to correspond. The compound consisted of a quart of wheat flour, one egg, one-third teaspoon of sugar, and one-fifth of a pint of lean boiled pork! He stated that it kept for a long time and was much appreciated by his fishes.

664. What have the Japanese found to be the most desirable food for Goldfishes?

The Japanese prepare a boiled mash of 80 parts of wheat and 20 parts of corn meal, with a dash of ground shrimp for flavor and to provide lime, which every animal needs. (Lime can be provided also with ground bone.)

In feeding Goldfishes in open ponds, one Japanese method is to sink the food in porcelain dishes to prevent contamination of the water, one-half foot below the surface for adult fishes, two inches below for larval fishes.

665. Name some foods which have been used successfully at American Goldfish farms.

Corn cut from the cob, raw or cooked, toasted bread crumbs, crumbled zwieback, ground puppy biscuits, thick sour milk, cream or cottage cheese, boiled vegetables, boiled cereals, raw or boiled roe of marine fishes, boiled vermicelli, raw mussels or clams, crumbled graham crackers, stale bread, peanut meal, soy bean meal, wheat and corn middlings, "Menhaden type fertilizer," liver meal, Cod liver, and egg yolk.

666. What are the spawning habits of the Goldfish?

It begins to breed at two years, is excellent for spawning when between four and five years, but breeds for some years longer.

Spawning occurs several times from March to July, or May to September, at a temperature of about 60°. It is customary to segregate the females in January and February to prevent the males from chasing or driving them—an exhausting procedure.

From 2,000 to 70,000 eggs are laid each year, according to the age of the female. Five hundred or more may be laid in one day. They are the size of a pin-head and resemble soap bubbles. In small quarters the parents will eat the eggs immediately. Some breeders think it well to allow them to eat a few of the eggs for stimulant.

The fry have a better chance where there is plenty of vegetation. They hatch in three to six days at a temperature of 60° to 70°, in the lesser time at the higher temperature. The hardiest fry emerge from the egg tail first and are at birth three-sixteenths of an inch long. The yolk sac is absorbed in about three days and the fry then begin to swim about in search of food. At this stage they look and act like mosquito larvæ. They are cannibalistic, larger eating smaller. They swim at the surface and should be protected from rain in outdoor pools and from drafts indoors. Usually they assume the adult form and color at six weeks, but sometimes much later.

Many novices have succeeded with the fry, though the youngsters should be placed in an aquarium by themselves if the eggs have been laid in an indoor tank. Great care must be taken in transferring them to water of the same temperature. The Japanese provide spawning fishes with *Ceratophyllum* and willow roots for catching the eggs, and at American hatcheries *Cabomba* often is used, also *Myriophyllum* and the roots of the water hyacinth, the custom being to transfer the plants, with the eggs attached, to an aquarium apart from the parents. The eggs are glutinous and adhere to the vegetation they fall upon.

667. What is the best food for Goldfish fry?

Some baby fish foods consisting of finely ground shrimp, ground clam, desiccated egg yolk, et cetera, may be purchased, but as live food always is best, it is customary to feed the young first with infusoria and other animalcules. Oatmeal broth, or the yolk of hard-boiled eggs pressed through cheesecloth or a fine tea strainer, provide an excellent food for the first three months, the most delicate period in a Goldfish's life, and clean earth always should be provided for them to browse in. Live *Daphnia* and earthworms finely chopped are desirable food for fingerlings when procurable.

The rule with fish culturists is to feed infant fishes five times a day during the first three weeks or so, then three times a day for a few more weeks, then twice daily, and finally at the end of three months, once a day.

668. What disease often kills all the fry of Goldfishes raised indoors?

Gill fever—a simple cold, contracted because of a draft over the surface of the water where they congregate, or by crowding, or too much dry food. The surface should be screened with muslin when there is danger of a draft.

669. How can one tell when Goldfishes are ready to spawn and when spawning is over?

In the mating season the males are distinguished by a "pearl beading" on the gill covers and pectoral fins, and the females by the distention of their bodies with eggs. The males drive the females about the tank. When they cease driving the females, spawning is over.

670. Can sex in Goldfishes be determined except in the spawning season?

According to German authorities, the sex can be told at all times by an anal depression in the male and an anal protrusion in the female.

671. Why do Goldfishes become egg-bound?

Because of underfeeding, stagnant water or other unnatural environment. An egg-bound fish may die unless relieved. (See No. 962.)

672. Why do Goldfishes usually die in a short time in the home aquarium?

The three common mistakes of the novice which have killed enough Goldfishes to stock all the waters of the United States are chilling, overcrowding and overfeeding. Thermometers, aerators and good judgment may obviate these errors.

673. How many Goldfishes are bred in the United States annually?

The latest survey of this industry made by the Bureau of Fisheries was for the year 1928, when there were about 770 commercial Goldfish ponds in this country. The production for that year was 21,500,000 Goldfishes, valued by the producers at \$942,000. Of these, 17,000,000 were Common straight-tails, worth \$573,000, and 4,500,000 were fancy breeds, largely Comets, worth \$369,000.

It has been assumed, in view of the craze for toy tropicals, that the production of Goldfishes had been greatly diminished; but an estimate made by a reliable Goldfish breeder places the production in 1934 at 26,000,000, with 6,000,000 imported from Japan. Efforts are being made to restore the fancy variations.

674. How was the monogrammed Goldfish produced?

The monogrammed Goldfish arose in connection with pigment studies at Wesleyan University, carried on by Dr. H. B. Goodrich

and Rowena N. Mercer. It was found that red scales planted on white areas would retain their color, but white scales put on red skin would become invaded by red pigment. The fish was anesthetized with chlorotone, some of its living scales plucked out of their pockets and transferred quickly to pockets made ready for them, until the monogram had been produced. The specimen lived only four months.

675. Is there any remedy for split fin in a Goldfish?

If this is a natural separation of the fin, little can be done. If it really is a split, it will heal itself.

676. Can all types of Goldfishes be kept together, and do they get on with native fishes?

Goldfishes are snobbish and each type does best by itself. If one has a collection, however small, of one kind and introduces a specimen of another kind, the newcomer will be set upon, its fins torn and its life made miserable, if not impossible. If in the beginning the aquarium is stocked with several kinds and all individuals must get acquainted together with their new quarters, there is a better chance of success. They do not molest other species, and among northern native fishes which may be kept with Goldfishes are docile Sunfishes (Little, Peacock, Everglades Pigmy, Orange-spotted, Diamond and Black-banded), Suckers, Black-banded Dace, Catfishes, Roach (American and Pearl), Chubs, Killies and Silverfins.

677. What temperature is suitable for Goldfishes?

They like cool water—59° to 65°, but will thrive and breed in living-room temperature, 68° to 72°. Warmer water distresses them, especially in small quarters. In the wild state, they breed in water of about 60°.

EUROPEAN FISHES

678. Which European fishes are most popular in American home aquariums?

The Loaches, commonly used as scavengers and of which there are several species, including the Marbled Loach (*Nemachilus barbatulus*), Spined Loach (*Cobitis taenia*), and Weatherfish (*Misgurnus fossilis*); the Bitterling (*Rhodeus sericeus*), the Golden Tench (*Tinca auratus*) which is a relative of the Common Tench (*T. vulgaris*), sometimes used in garden pools, and the Golden Ide or Orfe (*Leuciscus orfus*). All are of even disposition, though large specimens of Golden Ide are predacious.

THE LOACHES

(FAMILY COBITIDÆ)

679. How can one tell the Loaches apart?

The distinguishing marks in Loaches are the size of the fish, the number of its barbels, the eye fold, and the character of the suborbital spine and fins.

The barbels: The Marbled Loach has six barbels, all on the upper lip. The four middle ones are nearer together and those at the angle of the mouth extend back to the pre-operculum.

The Weatherfish has 10 barbels, four nearly equally distanced on the upper lip, four short ones on the lower lip, and one long barbel at each angle of the mouth.

The Spined Loach has a mouth beset with six short barbels, two close together in the middle of the upper jaw, and two longer ones at each angle of the mouth.

(The Dojo has 10 barbels, six on the upper lip and four on the lower, and the Malay Loach has six barbels, all upper.)

The size: The Marbled Loach is smaller than the Weatherfish, seldom exceeding four inches and with a maximum of five and one-half. The body is less elongated, the head larger and broader, and the mouth larger.

The Weatherfish reaches a maximum length of one foot, but most aquarium specimens average about four inches.

The Spined Loach is the smallest of European Loaches, with a recorded maximum length of four inches in Germany, France and Japan, and three inches in England. In Austria many mature speci-

mens have been taken which measured only two and one-half inches. The body of the Spined Loach is more compressed than that of *Nemachilus* and *Misgurnus*, and the back is arched.

The eye fold: In the Marbled Loach the skin does not cover the eye, but forms an immovable flat band toward the opercular border. In the Weatherfish and Spined Loach, the thin skin goes over the eye without forming a fold.

The suborbital spine: In the Spined Loach both points of the erectile suborbital spine are curved backward. In the Weatherfish this spine is completely covered by skin and cannot be erected.

The fins and scales: In the Marbled Loach, the caudal and pectorals are rounded and the latter are less deep than those of the Weatherfish. The fins of the Weatherfish are small, also its eye, and though entirely distinct from the Dojo, it is regarded as its European representative.

The scales of the Marbled Loach are so small and delicate that they can be seen only under magnification, and the head, breast and abdomen are scaleless.

680. What are the characteristics of the Loaches?

Most Loaches roil the water, wallow in mud or sand, and as a favorite pastime take mouthfuls of sand, squirting it back through the gill openings. They swallow air, which is absorbed by the walls of the intestinal tract, and, like other air-utilizing fishes, are able to withstand very foul water.

The Marbled Loach is shy, hiding under stones, also fragile, as it dies quickly when removed from the water.

The Spined Loach burrows like a rabbit and is said to emit a peculiar sound when captured.

The name of loach is from *locher*—to fidget, and this is particularly applicable to the Weatherfish which becomes active and uneasy 24 hours before a storm, when it frequently seeks the surface. Hence the name of Weatherfish. It is sometimes kept in aquaria to act as a barometer. According to the Cambridge Natural History, its air bladder may serve as a sensory organ connected with the skin in such a way as to convey "thermo-barometrical impressions to the auditory nerves." It is extremely resistant to desiccation and can endure for a long time out of water, sometimes being found in dry ditches.

681. What are the natural and artificial foods of the Loaches?

Loaches eat worms, insects, fish spawn and aquatic vegetation. The Weatherfish swallows mud for the organic matter it contains.

In captivity they like bits of meat, fish and shellfish (such as clam and mussel), with the leaves of some fine plants.

They thrive in living-room temperature (68° to 72°) and will survive for upwards of two years. *

682. What are the range and habitat of the Marbled Loach?

This Loach is widespread over central and western Europe, is common in the British Isles, and is found in all the fresh waters of Russia except beyond the Caucasus. It was introduced into Sweden by Frederick I. There are 40 species of *Nemachilus*, but this is said to be the only one indigenous to Europe. It inhabits lakes, rivers and clear brooks with gravelly bottoms, and does not thrive in stagnant water.

683. What are the colors and breeding habits of the Marbled Loach?

The green back and yellow sides are marbled with black, the abdomen is gray, and most specimens show an ocellus at the base of the caudal fin. The ventrals are pale yellow, but the other fins are marbled like the sides.

In England this species spawns in March or early April, in northern Germany from April or May until August in warm seasons.

The eggs are numerous and are deposited between stones or in hollows excavated by the father, who remains on guard.

684. What is the range of the Spined Loach, *Cobitis taenia*?

This Loach ranges through Europe from Spain to Scandinavia (though it is absent from Ireland) and is found also in Japan and India (in Bengal and Assam). In Japan it is called the Striped Loach and Hawk-wing Loach. (Bibliography No. 55.)

685. What are the colors and breeding season of the Spined Loach?

This species is called the prettiest of the Loaches. The striking orange yellow body bears numerous round black spots, some of which form two almost regular rows. No spots are present on the throat or abdomen. Small scales clothe the trunk, but the head is naked. There are three black lines on the head, one running from the eye to the upper lip, one running under the eye across the cheek, and one forming a wavy line back of the eye, to the end of the

* All temperatures are Fahrenheit.

operculum. A black ocellus lies at the base of the caudal, which is vertically striped while the other fins are pale. The iris is pale yellow.

In the male the upper ray of the pectorals is enlarged and flattened.

It spawns in March and April in France, April and May in Germany and Austria, and is exceedingly prolific like other Loaches, also hardy, surviving for upwards of 10 years.

685. What are the range and habitat of the Pond Loach or Weatherfish, *Misgurnus fossilis*?

This interesting fish is found through Holland, Belgium, the eastern border of France, north and south Germany, and in the fresh waters of Russia except in the basin of the White Sea and region beyond the Caucasus. It prefers muddy brooks, marshes and ditches, though it is found also in large lakes and rivers. In Switzerland it lives in Lake Constance. It is called Mudfish on the Continent because of its habit of burrowing. One species of this genus (*Misgurnus*) occurs in Bengal, others in China and Japan.

687. What are the colors and breeding habits of the Weatherfish?

The colors are brown and orange, with a lateral black band from the gills to the middle of the side, broad yellow stripes running above and below it. The head is marbled with brown flecks, some of which run together and form stripes. The abdomen is white or pale orange, sometimes dotted with black. The iris is golden.

The pectoral fins of the male are pointed, those of the female round. During the breeding season the female is easily identified by her heavy body distended with eggs.

Spawning occurs in spring—April and May in western Europe, April to June in eastern Europe.

The Weatherfish lays as many as 140,000 brown eggs on water plants, so large a number indicating that the fish has many natural enemies which keep its species in check. It has bred in captivity. Major Stanley S. Flower records its longevity as upwards of 22 years.

BITTERLING, TENCH AND GOLDEN IDE

(FAMILY CYPRINIDÆ)

688. What are the range and habitat of the Bitterling or Bitter Carp, *Rhodeus sericeus* (formerly *R. amarus*)?

It is distributed widely over central Europe, being particularly abundant in Germany, Holland and France, though absent from

Great Britain and Scandinavia. Its preference is for flowing water with a stony bottom, and it lives in rivers and brooks.

The Arabic name *amarus*—bitter, alludes to the flavor, said to be so repugnant to fishes in general that only Perch and Eels will eat it.

Two other species of this genus are found in China.

About 1921, Bitterlings were found in the Sawmill River, New York, where they had bred in large numbers. So many were gathered as curiosities for private and public aquariums that the stock was greatly depleted and it is believed that the remainder did not succeed in establishing themselves permanently. (Bibliography No. 198.)

689. What are the colors and spawning habits of the Bitterlings?

The courting colors of the male make him a gorgeous little creature during the breeding months. His back, sides and gill covers become suffused with rich violet, and through this an emerald lateral stripe extends from the center of the body to the tail; his silvery abdomen becomes spotted with rose or orange red, matched by a similarly colored stripe on the operculum, dotted with violet. His dorsal is brown, banded with black, his anal bright red with a black margin, and his iris bears a flash of ruby. At other times his color is silver with a touch of rose in the fins. The females normally are silvery, with yellowish backs and a blue lateral stripe from the middle of the body to the tail, but in the spawning season their backs become greenish brown. Their irises are pale lemon, spotted with orange. The ovipositor is orange red.

This is one of the smallest of European fresh-water fishes, with a maximum length of three inches for the male, two inches for the female. Many females do not exceed one and one-half inches.

It spawns generally in May and June, as early as April in Austria and as late as August in the Seine. Then the male develops tubercles on his upper jaw and above the eyes, and the female uses her long, dangling ovipositor to deposit her eggs in the excurrent siphon of the fresh-water mussel, without which the Bitterling does not breed. Large yellow ova move down the ovipositor like little amber beads, and are deposited a few in each of several shells. An interchange of service is believed to take place between the two animals, the parasitic young mussels being liberated by their mother at the proper moment for attachment to the Bitterling while she is depositing her eggs in the siphon of the mussel, and the young fishes and mussels leave their respective hosts coincidentally in about three or four weeks. After spawning, the ovipositor gradually withdraws into the papilla. Amer-

ican mussels as a rule adhere to fishes larger than the Bitterling and no American fish lays its eggs in a mussel shell.

This species, like other European fishes, thrives in living-room temperature, 68° to 72°.

690. Of what particular interest is the Bitterling?

Its singular breeding habits long have made it an object of curiosity.

Female Bitterlings, both European and Asiatic, now are imported into the United States in large numbers for the purpose of determining pregnancy. It is hoped that some chemical may be discovered which will serve the same purpose and avert the sacrifice of these remarkable little fishes.

691. What is the natural habitat of the Common Tench, *Tinca vulgaris*?

The Tench is found in every European country. In Germany it is called "Schleihe." It inhabits lakes, ponds, rivers and marshes, and can exist in dried-up mud during summer droughts. It is used as food.

692. What are the colors of the Common Tench?

The color runs from greenish brown to black, and the sides display a bronze tint caused by the scales, which, though embedded in the thick skin, shine through it as a number of glistening dull golden dots. There are over 100 of these on the lateral line.

All the fins are round, and there are barbels at the angles of the mouth.

The clearer the water in which the Tench lives, the brighter are its colors.

693. What are the spawning habits of the Common Tench?

It spawns from May to August, depositing its adhesive eggs near the banks of the waters in which it lives, and sometimes these become attached to the Tench Weed. Two males attend each female. The fry hatch in seven days and may number 300,000 if the mother is a large fish.

The natural food consists of aquatic worms, insects, mollusks and a species of *Potamogeton* called after it the Tench Weed. It is said not to eat other fishes.

The Tench is hardy in the home aquarium but suitable only when very young, growing so large that, like the Golden Ide, it does better in a pond, best of all in a pond with a muddy bottom. The maximum length is one foot, the duration of life seven years.

694. Of what interest is the Common Tench?

The fish is of an amiable nature, sluggish and given to burrowing in the mud. It has been called an "idle, meditative fish" and can be caught in the hand while napping. It is known as "Dr. Tench" because of an old superstition that it can heal the wounds of other fishes, particularly those of the Pike. Also, because it formerly was employed in medicine, being applied externally to absorb poisons and in the making of poultices. It can live for many hours out of water.

Its chief enemy, other than man appears to be the Trout.

695. What is the habitat of the Golden Tench, *Tinca auratus*?

Like the Common Tench it ranges through Europe and has been recorded also from Asia Minor.

696. What are the colors of the Golden Tench?

This species is a translucent gold, with red lips and numerous irregular black spots. The fins are pink, the eye golden with a brown or ruby iris. It is called one of the most beautiful of European fishes.



Courtesy California Academy of Sciences, Steinhart Aquarium

The Golden Tench is called one of the most beautiful of European fishes. It is translucent gold with red lips, pink fins, and a golden eye with brown or ruby iris.

697. What is the natural habitat of the Golden Ide or Orfe?

The Ide is widely distributed in western Europe and is especially abundant in Germany and Sweden.

Unsuccessful attempts were made many years ago to establish it in Washington, District of Columbia. Its revived favor as a garden pool fish may lead to better results.

698. What are the colors and characteristics of the Golden Ide?

This species is a variation of the common silver and yellow Ide or Orfe. It resembles the Goldfish in color, with a display of rich vermillion or orange red on the back and sides. The belly is silvery. A broad faint lateral band of violet runs through the tail, and back from the tail down to the abdomen. All the fins are red, with white tips. The iris is golden, with a black pupil. In the spawning season (April and May) the colors become very bright. It is a pretty fish for the aquarium or garden pool, but is a rapid grower, attaining an average length of 12 inches, with a maximum of 20. It is a hardy species and will survive for more than five years in running water.

It has been said of this fish that it is "active as a Dace, inquisitive as a Minnow, and glorious as a Goldfish." Larger specimens are predacious and because of this and the fact that they are surface swimmers and leap from the water, they sometimes are miscalled Golden Trout.

The Ide is used for food in Europe, having formerly been considered a very great delicacy for sick people, particularly expectant mothers.

699. What foods will the Bitterling, Ide and Tench take in captivity?

Prepared foods and the standard foods given American species. (See No. 187.)

NORTHERN NATIVE FISHES

700. Which are the most desirable of native fishes in the northern United States for the home aquarium?

Many small natives do well in household aquaria—Darters, Sunfishes, Suckers, Roaches, Dace, Killifishes, Minnows, the Eel, Miller's Thumbs, Catfishes, Sticklebacks and others.

701. What temperature is suitable for northern native species?

Many thrive and breed in living-room temperature, 68° to 72°,* but some species like the water cooler, as Dace and other river fishes, also fishes from large, cool lakes. Those from swamps and sluggish streams are comfortable if kept at summer heat. One must judge the proper temperature by the habitat.

702. Which species of northern native fishes build a nest?

Various species of Sunfishes, including the Peacock and Common Sunny, scoop a depression for their eggs, as do also the Bullhead and other Catfishes, the Silver Dace or Common Shiner, and others. The Horned Dace edges his nest with pebbles. The Bowfin, Pirate Perch and Mud Minnow use plants in the construction of their nests, and the Sticklebacks build elaborate nests, glued together.

703. Which species of northern native fishes bring forth their young alive?

The Top Minnows *Gambusia* and *Heterandria*, which breed in the home aquarium, also Trask's Perch, which breeds in the garden pool.

704. How long do northern native fishes live in captivity?

In running water, the Eel has survived for six years, the Common Roach for seven years, and the Bowfin for 20 years. In the balanced aquarium, the Black-nosed Dace and Mosquito Fish have survived for eight years, and the *chaetodon* for 10 years.

* All temperatures are Fahrenheit.

THE BOWFIN

(FAMILY AMIIDÆ)

705. What are the range and habitat of the Bowfin (*Amia calva*)?

In the Great Lakes, particularly Lake Champlain though not in Lake Superior, in sluggish waters to Minnesota and Virginia and south to Florida and Texas, ranges this historic fish. It is known by a variety of names including Dogfish, Mudfish, Marshfish, Lawyer, Grindle and John A. Grindle. In Louisiana it is called the Choupique, and there it inhabits sluggish, weedy waters, frequenting the shallows by night and returning to the deeper places by day.

The Bowfin is a desirable fish for the home aquarium only when very young, attaining a length of 10 inches in its first year. It is voracious and cannibalistic, and a terrible fighter and biter when its life is in danger; but the beauty of young specimens cannot be resisted if one is fortunate enough to secure them and can keep them by themselves.

706. What are the colors and breeding habits of the Bowfin?

Young specimens of from three to five inches are barred horizontally with orange, the sides mottled, and the fins tinted with bright green, yellow and red, and bordered with black. The gills are suffused with scarlet. The gracefully waving dorsal fin extends from just behind the pectoral to the root of the tail, where the characteristic round black spot is one of the striking markings of the fish. The adults are dark green, spotted with black, and the male is distinguished by a yellow or orange circle round the tail spot.

The Bowfin does not breed in captivity, but if one is looking for young specimens it is well to know that spawning takes place at night, preferably in a stagnant slough, and the fry hatch nine days after the eggs are laid, i. e., about the first of May, when they are one-third of an inch long. By the middle of June they are four inches long.

The male fish builds a tunnel-shaped nest with a bed of rootlets, sand and gravel, and guards it. The fry remain nine days in the nest, attached to rootlets by an adhesive organ on the snout, and also lie on their sides on the bottom of the nest. When they leave the nest, they swarm about the father, enveloping him in a cloud or schooling beside him, until they have passed the fingerling stage, about the middle of June. Some observers believe they swim into his mouth for protection.



The Bowfin is an historic fish and young specimens are beautiful for the aquarium. A very knowing expression is accentuated by two tiny mustachelike barbels at the ends of the nostrils.

The natural food consists of small fishes, snails, aquatic insects and crustaceans, particularly crayfishes. In captivity, small live fishes, fresh beef, chopped clams and mussels are taken.

The Bowfin will survive for more than 20 years if one can accommodate it as long as that.

707. What are the interesting characteristics of the Bowfin?

It is one of the famous ganoids whose skeletons are found in Palaeozoic and Mesozoic remains. It is the only living representative of its order and family. Its air bladder is cellular and acts as a lung, enabling it to live out of water for some time. It has a very knowing expression, accentuated by two tiny, mustachelike barbels at the ends of the nostrils.

THE EEL

(FAMILY ANGUILLIDÆ)

708. Is the American fresh-water Eel (*Anguilla rostrata*) a desirable fish for the home aquarium?

It is desirable only when very young. Care must be taken in introducing an Eel, however small, into an aquarium with other

fishes. It does well with Killifishes and Minnows, but is not friendly toward Goldfishes, and will eat every snail in sight.

Its chief diet in a state of nature consists largely of snails and fish eggs. In captivity it readily takes almost any food that is offered.

709. What are the range and habitat of the American freshwater Eel?

Eels are found ascending all rivers south of Canada and east of the Rockies, individuals sometimes becoming resident throughout the Mississippi Valley. From the rivers they penetrate into lakes and ponds, frequenting the mud.

710. What are the breeding habits of the Eel?

Eels breed, (and this applies to both American and European forms) in the deep waters of the Sargasso Sea, which lies north of the West Indies and south of Bermuda. Here the adults congregate to deposit their spawn and die. When the little Eels hatch they resemble deep-sea fishes, but metamorphose before reaching the surface, where the fry of the European species start their long journey to Europe and the fry of the American species make their way to the North Atlantic shores. When the young Eels, called elvers, reach the latitude of New York, they are about two inches long and may be seen by thousands along the shore and among the seaweed, also in bays and estuaries. There the sexes separate, the males remaining in salt water, the females ascending the rivers, sometimes to a great distance. If the Eels are to be kept in fresh water one should catch those ascending the rivers or which have reached their destination in some lake or pond. (The females remain in fresh water for from five to 30 years before descending the rivers to join the males along shore, then all set out together for their long, last journey back to the spawning grounds, and never are seen again.)

The maximum length of the male Eel is two feet, that of the female, six feet.

711. What are some interesting facts about the American freshwater Eel?

It is a very graceful fish, becoming tame enough to eat from one's fingers, and is a wonderful scavenger, overlooking nothing that has escaped its companions. For centuries its habits were shrouded in mystery. Johannes Schmidt, a Danish naturalist, after many years of study, established all the Eel's stages save the egg. Mrs. Marie Poland Fish first saw a fully developed Eel egg and witnessed its hatching. (Bibliography No. 45.)

The Eel is interesting also because it can travel a considerable distance through moist grass, from one body of water to another. It has survived for six years in captivity.

SUCKERS

(FAMILY CATOSTOMIDÆ)

712. How many of the Suckers are desirable for the home aquarium?

The United States boasts nearly 50 kinds of Suckers, any of which may be used in the home aquarium when young. They are very abundant southward. Some have the ability to support themselves on their paired fins, like Darters.

Young specimens of the Chub Sucker (*Erimyzon sucetta*) and Brook or Common Sucker (*Catostomus commersoni*) are beautiful for the home aquarium. The Sweet Sucker or Pin Minnow (*E. oblongus*), which intergrades with the Chub Sucker, is more abundant northward.

713. What are the range and habitat of the Chub Sucker?

It is found from the Great Lakes to the Mississippi Valley, and in coastwise streams from Pennsylvania south to Virginia and Texas. One would look for it in lakes and lowland streams.

714. What are the colors and foods of the Chub Sucker?

The color varies with age, being normally brown with black sides, a silver or copper luster, and reddish fins. The young are banded.

The natural food consists of crustaceans, insect larvæ and aquatic plants. The teeth, like the Goldfish's, are in the throat (pharyngeal teeth), and the food therefore is similar. Suckers are bottom feeders, sucking up ooze and slime together with insect larvæ and other edibles.

In captivity they will take Goldfish foods. (See Nos. 664, 665.)

715. How can the Chub Sucker be distinguished from the Black-nosed Dace?

The Chub Sucker has a long, slender body, banded with black from snout to tail, is distinguished by its much larger scales, also because it loses its lateral band before attaining full growth, while the Black-nosed Dace retains the band through life. The Chub Sucker also has a typical sucker mouth which points downward and is fitted

for bottom feeding. Like all other Suckers it is suitable for the home aquarium only when of small size.

716. What are the range and habitat of the Brook Sucker?

Commonest of the Suckers, it is found from Quebec and the Great Lakes to Montana and Colorado, and south to Missouri and Georgia, and is exceptionally abundant from Massachusetts west to Kansas.

It prefers clear, swift waters with rocky or sandy bottoms, but is found also in ponds and creeks. It can be caught in the hand in shallow streams and is said to enter slightly brackish waters. In Montana it is called the White Sucker.

717. What are the colors, spawning habits and foods of the Brook Sucker?

The sides are olive silver and the fins pigmented with red. During the mating season the male develops a faintly rosy lateral band.

Spawning occurs in the spring in the head waters of small streams, each female being accompanied by two males which press against her sides and scatter their milt over the eggs as these are extruded. The eggs are left to hatch as best they may. The fry reach a length of one inch in about six weeks, but do not acquire the sucking mouth until later (i. e., they hatch with a terminal mouth). The adult length is from 16 to 18 inches maximum.

The Brook Sucker's natural food consists of worms, mollusks, and fish fry; and it swallows mud containing diatoms, fish eggs, insect larvæ and minute crustaceans. It is one of the various fishes which prey on the eggs of Salmon and Trout, and is of economic importance in this respect.

718. What are the characteristics of the Brook Sucker?

It is tenacious of life and can be frozen and thawed out. It has a double chambered air bladder.

The Sacramento Sucker (*C. occidentalis*), an allied species of Oregon and California, disappears from many creeks during drought and returns.

DACE, ROACHES, STONE-ROLLER AND MINNOWS

(FAMILY CYPRINIDÆ)

719. Which Dace are most commonly used in aquaria?

The best known to the aquarist are the Silver Dace, called also Silverfin, Common Shiner and Rechin (*Luxilus cornutus*), the Black-

horned Dace, Brook Minnow or Striped Dace* (*Rhinichthys atronasmus*), Silver Chub (*Semotilus atromaculatus*), called also Horned Dace and Creek Chub, Red-bellied Dace (*Chrosomus erythrogaster*), and Rosy Dace or Long-mouthed Minnow (*Clinostomus vandoisulus*).

Dace in general reach a length of about three inches.

720. What is the range of the Silver Dace?

The Silver Dace or Common Shiner is typically a river fish, and is common also in ponds in the eastern states, where it swims with the Roach, from which it is distinguished by its narrow body. It is found everywhere east of the Rockies except in the South Atlantic states and Texas, and in some localities descends to brackish waters, where it swims in immense schools with the Fresh-water Killie. It loves the eddies of quiet streams, small brooks and rivers, and appears to be impervious to changes of water temperature and salinity.

721. What are the colors and breeding habits of the Silver Dace?

The Silver Dace has a silver blue compressed body. In the breeding season the back of the male becomes bluer, his sides and fin margins blood red, and tubercles develop on his head. The scales are extremely deep.

It breeds in May and June, depositing the eggs in a hole or "nest" scooped in the gravelly shoal of some swift current.

It sometimes exceeds the average maximum length of Dace and attains to five inches. Eight inch specimens have been taken.

One-third of its food consists of algæ. It takes also insects and fish fry.

722. What are the range and habitat of the Rosy Dace?

The Rosy Dace or Long-mouthed Minnow is found in the District of Columbia, Tennessee, Virginia and the Carolinas, where it lives in springs and rivers. The specific name *vandoisulus* is from the French *vandoise*, dace.

723. What are the colors of the Rosy Dace?

Silver blue and green are the colors, with a greenish pink stripe from gills to tail. The lateral band is dark, a pale streak lying above it. The body of the breeding male is rose red.

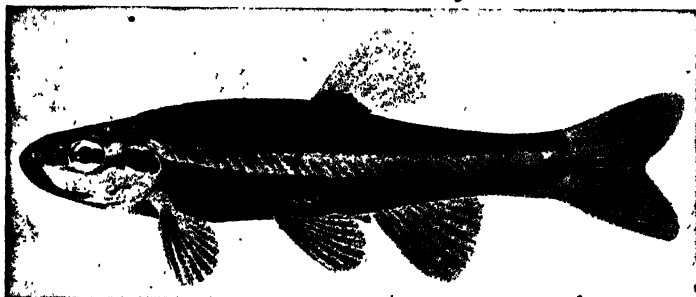
The average length is six inches, though specimens longer than five seldom are seen.

724. What are the range and habitat of the Red-bellied Dace?

This showy fish ranges from New Brunswick south to Alabama and west to Colorado, being very abundant in the Mississippi region and in Wisconsin. Generally it is found in small, clear streams, where it breeds in late spring and early summer, and is common in the Kentucky and Tennessee rivers and their tributaries.

725. What are the colors and foods of the Red-bellied Dace?

In this species, which averages about three inches in length, rich black velvety bands enclose the orange lateral band, offset in the male in the breeding season by streaks of bright red on the sides and belly.



From The Fishes of Illinois, by Forbes and Richardson

By common assent, the Red-bellied Dace is the handsomest of dace, the orange lateral band being enclosed in rich black velvety stripes, offset in the male in the breeding season by streaks of bright red on the sides and belly. The average length is about three inches.

The Red-bellied Dace is an ideal fish for the community tank of native species, though it has not yet bred in captivity. By common assent it is the handsomest of Dace.

Mud, algæ and water fleas are its natural foods. It will take any fish food, but prefers crustaceans and algæ.

Living-room temperature (68° to 72°) suits it very well. Individuals have lasted two years in the aquarium.

726. What are the range and habitat of the Black-nosed Dace?

The Black-nosed Dace or Black-nosed Minnow is common almost everywhere from New England to Minnesota, Alabama and Virginia. It inhabits lakes and ponds and lives in trout streams in little pools among the rapids. It is easily smothered from under stones and can

be taken in a net set in the down-stream direction from its hiding place.

It never exceeds three inches and most specimens are smaller.

Like the Red-bellied Dace, this species gets along amicably in a community tank even with Goldfishes, whose tails it will not nibble, and has survived for eight years in the home aquarium.

727. What are the colors and breeding season of the Black-nosed Dace?

The body is fish green above and white below, with a long black stripe from snout to tail. In spring, the male becomes suffused with crimson over the entire body and lower fins, with a rich lateral band of reddish gold bordering the stripe.

It breeds in spring and early summer.

728. What are the range and habitat of the Horned Dace or Creek Chub?

It is found from Canada and Maine to New Jersey, west to Kansas and Wyoming, and south to Alabama. It is abundant in the Delaware basin. This little fish inhabits small brooks, sometimes in company with the Black-nosed Dace. It lives also in rivers, being particularly common in the Potomac.

729. What are the colors of the Horned Dace?

Both sexes are bluish brown above and white below, with a black spot at the base of the dorsal fin. Above the black spot in the male is an orange spot. His dorsal is edged with scarlet and in the breeding season he becomes apple green above and rose below, his caudal and paired fins yellow. His head becomes orange yellow, beset with two large tubercles on each side of the upper lip and a row of four on each side of the eye. These "pearl organs" are sharp enough to inflict a wound.

Both sexes have a lateral stripe. A distinguishing feature of this species is the crowding of the scales before the dorsal fin. The body is robust.

Mature males average eight to 10 inches in length; females sometimes are only one-fourth as long, or if as long, much smaller in body.

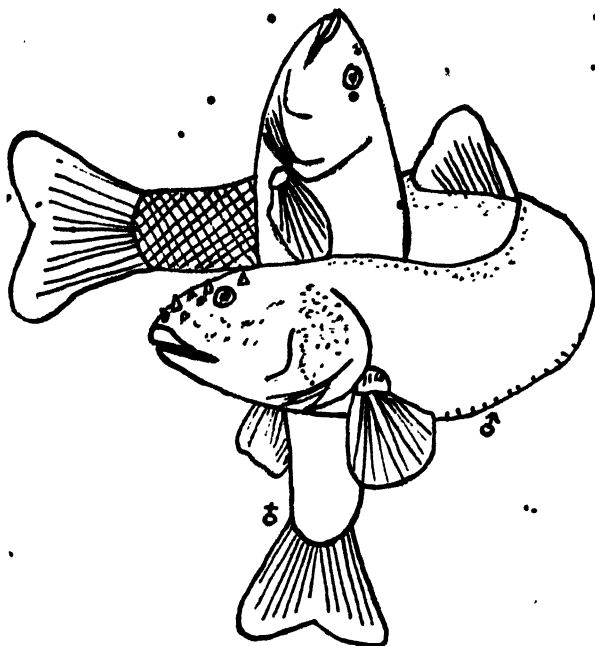
730. What are the characteristics of the Horned Dace?

It is a voracious fish, an active swimmer and has been called the "gamiest Minnow." It grows very tame in captivity, but cannot stand warm water.

731. What are the breeding habits of the Horned Dace?

It spawns generally in May and June, but in southern Michigan from April to early July.

Breeding takes place in clear streams, where the male excavates a nest in sand and edges it with small stones conveyed in his mouth



(After Jacob Reighard)

A Pair of Horned Dace during the Spawning Act

The male throws the female into a vertical position, always head up, and encircles her body, pressing against her sides with his fins to help her extrude the eggs. After this exhausting process she floats belly up as though dead, while he searches for eggs which have scattered, to make sure they are fertilized and confined within the nest. She recovers and returns to lay more eggs.

and pushed into place with his snout. When complete it is two to three inches high and 12 to 18 inches wide. He defends the uncompleted nest, giving battle to other males. The females are coy, approaching the nest and swimming away again, but one finally decides to remain. As described by Reighard, the male then throws her into a vertical position and encircles her body. Her head is always up and his opercle

and pectoral fins are pressed against one of her sides, his tail against the other. The embrace lasts a fraction of a second, during which 25 to 50 eggs are laid and fertilized. After this exhausting procedure she floats belly up as though dead, while he searches for eggs which have scattered, to make sure they are fertilized and confined within the nest. The female recovers and returns to lay more, and the eggs of several females may be laid in one nest.

Reighard says that when the nest is complete, the male deserts it and it rapidly becomes covered with silt. After the eggs hatch, the young make their way out through chinks between the stones. (Bibliography No. 224.)

732. What states does the Common Roach or Golden Shiner (*Notemigonus crysoleucas*) inhabit?

It has a wide range and is commonly found from Nova Scotia, New Brunswick and Quebec south to Florida and Texas, also in the Dakotas and Minnesota. It is one of the commonest of fresh-water fishes east of the Rockies, being exceedingly abundant in the Connecticut River and the State of New York. It has been introduced into California.

Its home is in stagnant ponds, muddy streams and small brooks, where it swims in schools. It is fond of sheltering under the yellow pond lily.

733. What are the colors, spawning habits and foods of the Common Roach?

Green and sparkling silver are the colors, with gold reflections. The ventral fins are bright orange in both sexes from the end of May to the end of July, when spawning takes place.

The eggs are adhesive, the young have black lateral bands from snout to tail fin, and attain a length of one and one-half inches in five months.

The adult length averages six inches, though specimens of 11 inches have been recorded.

The Roach gets along amicably with other small native fishes and with Goldfishes. It has lived for seven years in captivity, remaining active in cold water during the winter.

It preys largely on mosquito larvæ and other aquatic insects, worms and bugs, and swallows masses of mud from which it extracts protozoa and vegetable substances. It is said to eat wild rice. In captivity it accepts all foods commonly offered to Goldfishes, but the food must be finely ground because of its small gullet.

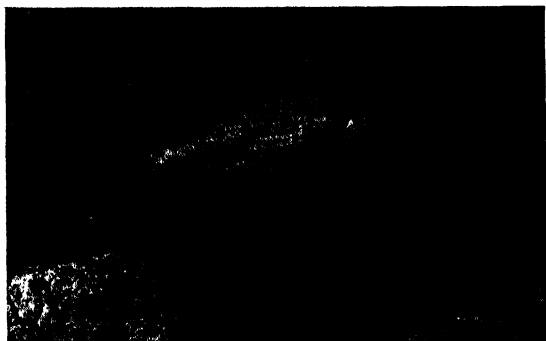
734. Is the Pearl Roach (*Scardinius erythrophthalmus*) related to the Common American Roach?

The Pearl Roach belongs in the same family, but is not closely related to the Common Roach, being of a different genus and species and not native to this continent. It was introduced from Great Britain where it is known as the Rudd or Red Eye and was discovered in 1894 in a lake in Central Park, New York City, from whence it has been widely transplanted to eastern and middle western states.

It favors deep waters and sheltering pools.

735. What are the colors and breeding habits of the Pearl Roach?

It is much prettier than our Common Roach, its glistening silver body being set off by vermillion caudal, ventral and anal fins, which



Pearl Roach

The glistening silver body is set off by vermillion caudal, ventral and anal fins, which present a velvety appearance; and in the adult the eye is red.

present a velvety appearance. In the adult the eye is red, whereas the eye of the fry is yellow. In northern Italy and the Engadine a breed with black fins is found and this is called by the Italians the Devil's Fish.

It breeds in spring and early summer, and at this time the scales become rough. In a state of nature the numerous adhesive eggs are laid near the margins of the water among aquatic plants.

This species averages 10 inches in length and reaches a maximum of 15.

It will survive over seven years in running water, being hardy and long-lived.

The Pearl Roach is omnivorous, with a marked taste for aquatic vegetation of all kinds, though it eats also small water animals such as snails and insects and is fond of the red worm, *Tubifex*. In captivity it will take almost anything offered, such as bits of lettuce, ant eggs, cereals cooked or raw, chopped raw beef, fish, and shellfish.

It is suitable for the home aquarium only when small unless provided with running water without plants, except those thrown in for food.

736. Which Roaches are found on the west coast?

At least six species of the genus *Hesperoleucas* are native to California, including the Symmetrical Roach, *H. symmetricus*, which exhibits great variation in color, is able to withstand drought, and is generally distributed in streams, brooks and rivers; the Navarro Roach, *H. navarroensis*, found in the Navarro Basin on the western coast of northern California; the Short-finned Roach, *H. parvipinnis*, of the Gualala River; Venus Roach, *H. venustus*, living in Russian River and streams entering San Pablo, Suisun and San Francisco bays; the Monterey Roach, *H. subditus*, found in the Pajaro River system in the region of foothills and lower mountain ranges of coast ranges.

The Northern Roach, *H. mitrulus*, has been taken only in Oregon in streams tributary to the north end of Goose Lake.

737. What are the range and habitat of the Stone-roller, *Camptostoma anomalum*?

This species might be called the eastern Stone-roller, for it is found in rivers, creeks and small streams from central New York to Tennessee, Wyoming and Texas. Other species live exclusively in the rivers of Mexico, California and Texas.

738. What are the colors of the Stone-roller?

Usually fish gray with indistinct vertical bars; but in the mating months the male is handsomely attired in a coat of gleaming silver, with orange and black dorsal and anal fins, while pearl organs form tiny ridges on his head and back in front of the dorsal fin.

We have no record of this species breeding in captivity.

It reaches a maximum length of six inches.

739. What are the interesting characteristics of the Stone-roller?

In public aquariums and biological laboratories it usually is pointed out as a curiosity, though its curious feature is hidden during life; this is, the singular coiling of the long intestinal tract around the air bladder. Also, the fish is provided with a bony ridge at the front of the strong upper jaw, which enables it to scrape the fine algæ from stones, and in the process to roll them, hence its name. It is a sturdy little fish.

The long intestine reveals its adaptation to a vegetable diet (carnivorous fishes, like other carnivorous animals, having shorter intestines than herbivorous species). It browses on algæ and mud, from which microscopic plants and animals are extracted.

In captivity, the typical Goldfish foods are suitable. See Nos. 664, 665.

The Stone-roller will survive for upwards of one year in the aquarium.

740. What, exactly, is a Minnow?

The word Minnow derives from *minimus*, meaning *the least*. Therefore Minnow is a name generally applied to various small fishes of both fresh and salt water, but a three foot Squawfish of California also figures as a "Minnie." The common fresh-water Minnow of the eastern states is the Black-nosed Dace, and the common salt-water Minnow is the Common Killie. Most of the Minnows belong in the family Cyprinidæ, but some of the Killies of the family Cyprinodontidæ also are called Minnows.

So many Minnows are called Redfin, Silverfin and Shiner, that these names are to be guarded against.

741. Which Minnows are most desirable for the home aquarium?

First, the live-bearing Top Minnows of which there are many species. In the middle western states an attractive species is the Blunt-nosed Minnow. Very intelligent (also pugnacious) are the Mud Minnows, which are Pikes, and Satisfins of the east and west, which are true Minnows. The Mud Minnows are Eastern and Western, the Eastern being called also Rock Fish. The Western is called also Dog-fish. It has been said that no tropical fish ever was more beautiful than a Blackfin Minnow, or the Common Shiner, Redfin and other middle western Cyprinids.

The best known Top Minnows are *Gambusia holbrooki*, *G. pa-*

truelis, formerly known very commonly as *Gambusia affinis*, and the American Top Minnow (*Heterandria formosa*).

742. What are the range and habitat of the Satinfín Minnows?

Erogala whipplii is found west of the Alleghanies, *E. analostana* east of the Alleghanies. They live in clear streams. In some states they are called Steel-colored Minnows.

743. What are the colors of the Satinfín Minnows?

The body is steely blue with black-rimmed scales. The males in the breeding season are arrayed in a coat of rainbow tints, in which orange, green and violet predominate.

The Satinfíns are hardy, friendly and playful, and are classified as true Minnows.

744. What are the range and habitat of the Blunt-nosed Minnow or Spotted Minnow (*Hyborhynchus notatus*)?

It ranges in lakes and streams from Quebec to Delaware, Kentucky, Tennessee, Alabama, Arkansas, and north to the Dakotas, and is very common in small streams west of the Alleghanies. It is fond of muddy shoals and gravelly bottoms.

745. What are the colors and breeding habits of the Blunt-nosed Minnow?

It is not brilliantly colored, the trunk being greenish blue, lighted with dull silver and adorned by two black spots, one at the base of the caudal and the other at the base of the dorsal fin. In the spawning months, the male dons a deeper shade of old silver and horny tubercles appear on his snout, like those of the Horned Dace.

Breeding takes place in cold water two feet deep, from late May to mid-July. The eggs are glued in a mass to the under surfaces of stones or other fixed objects and the father remains near-by to drive away intruders. We have no record of this species spawning in the aquarium.

A maximum length of four inches is attained.

Slowly running water is best, otherwise cool standing water, aerated if necessary, to keep the temperature below 68°.

In a state of nature the Blunt-nosed Minnow swallows principally mud which is rich in algæ, and microscopic plants such as desmids and diatoms.

In captivity it takes the typical Goldfish foods. See Nos. 664, 665.

746. How is the Blunt-nosed Minnow distinguished from the Fathead Minnow or Blackhead Minnow (*Pimephales promelas*)?

In the Blunt-nosed Minnow the lateral line is unbroken from gill cover to tail; in the Fathead Minnow it is interrupted behind the dorsal. The Fathead also is a shorter fish.

747. What are the range and habitat of the River Chub, Midian Chub, or Hornyhead, *Nocomis kentuckiensis* (formerly *Hybopsis kentuckiensis*)?

This species ranges from Pennsylvania to Wyoming and Alabama on both sides of the Alleghanies, and is abundant in the larger streams. Usually it is to be found on the grassy bottom of the Potomac and its tributaries, and is common in West Virginia. In Illinois it lives in creeks and small rivers; but in North Carolina it inhabits rivers flowing into the Atlantic, and is found in tributaries of the French Broad. It was first named by Rafinesque in 1820.

748. What are the colors and spawning season of the Hornyhead?

The colors vary according to sex and season. Usually the top of the head and back are a rich green, the lower part of the sides and belly a pearly gray or yellow, with copper and green reflections. On side of the head is a spot of pale red which becomes brilliant in the spring in males, whose lower parts also become rosy. The dorsal, caudal and anal fins are orange. The fish has a stout body, a well developed barbel, and the top of the head in adults is raised into a high crest covered with tubercles—hence the name of Hornyhead. In young specimens there is a dark spot on the caudal fin.

This species spawns late in May and early in June. It averages six to eight inches, with a maximum of 10.

It is omnivorous, subsisting on thread algæ, seeds of grasses, insects and other small aquatic animals.

It is a very active and robust fish. The alimentary tract is unusually long because of its partiality for a vegetable menu. Its preference is for cool water.

749. What are the range and habitat of the Redfin Minnow (*Moniana lutrensis*)?

This species ranges from southern Illinois to South Dakota, Arkansas and Kansas and in the Rio Grande, and is very commonly found southward in clear brooks.

750. What are the colors and breeding season of the Redfin Minnow?

The fins of the male are tinged with reddish or orange, otherwise he resembles the fish gray female, with iridescent steel above.

Males in spring are strikingly colored, the steely blue sides becoming brilliant above and giving place to orange red or crimson below. Even the head, cheeks and opercles are flushed with red, the gill openings are bordered with rose, and all the fins are reddish. Both sexes develop small tubercles on the head, which are more numerous in the male.

The maximum length is two and three-quarter inches.

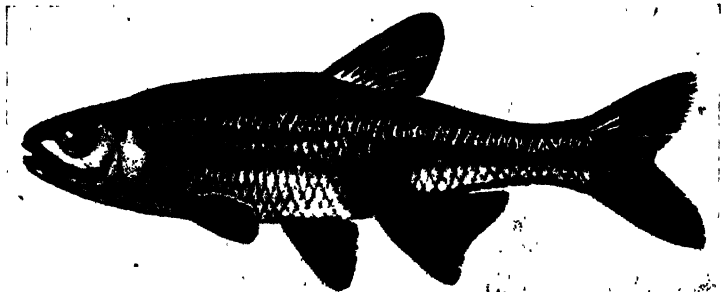
This species appears to intergrade with the Satinfin Minnow. It spawns from the middle of May to the end of June.

751. What are the range and habitat of the Blackfin Minnow (*Notropis umbratilis atripes*—formerly *Lythrurus atripes*)?

This minnow is found in southern Illinois and Iowa in clear, swift streams, also in creeks and still waters. It is widely distributed in lakes and rivers from New York and Ohio southeast to the Roanoke River, and south and west to Alabama and Arkansas, Missouri and Kansas.

752. What are the colors and habits of the Blackfin Minnow?

The female is plain olive. The male is dark purplish on the back.



From The Fishes of Illinois, by Forbes and Richards.

The Blackfin Minnow, Male

From May to August his head is covered with white tubercles. His back is dark purplish, sides greenish blue, belly green, while his pectorals are rosy and all the other fins rich red, with a tinge of green at the base of dorsal and caudal. Altogether the effect is so handsome that it is said of him, "No tropical fish ever was more beautiful."

his sides are greenish blue and his belly green. There is a dark horizontal band on his caudal peduncle. In breeding males, the dorsal and caudal fins are bright brick or blood red, with a green tinge at their base, the pectorals are pink or rose, and the lower fins a uniform red. The head of the male is covered with small white tubercles from May to August and altogether the effect is so handsome that it is said of him that "No tropical fish ever was more beautiful."

The length of this species is three and one-half inches.

Spawning occurs from the middle of May to the last of June.

• MUD MINNOWS

(FAMILY UMBRIDÆ)

753. What are the range and habitat of the Eastern Mud Minnow or Rock Fish, *Umbra pygmæa*?

From Long Island to North Carolina is its range. It lives in the mud or among the plants in lowland swamps and coastwise, swampy streams, also in ditches. Often it is found in foul, shallow water in which no other northern fish could live.

754. What are the colors, breeding habits and foods of the Eastern Mud Minnow?

The body is a warm brown with 12 longitudinal stripes and a black vertical line or two black dots at the base of the tail. A stripe runs through the eye. The sexes are similarly marked.

Four inches is the maximum length.

This species seldom has bred in captivity. A pair once taken while in the act of spawning in a bed of algæ were transferred to a thickly planted aquarium and resumed spawning after forming a hollow nest in a mass of algæ. They closed the nest from the side after the eggs had been laid and fertilized, and, strangely enough, it was the female who remained on guard. The fry hatched in six days and quit the nest about six days later. They grew rapidly, reaching a length of one and one-half inches in four months.

The Eastern Mud Minnow is decidedly carnivorous, eating snails, insects, crustaceans, and fishes and their eggs, but consumes also some vegetable matter.

Chopped meat, shellfish and flies are appreciated. Its appetite often fails in summer.

755. What are the characteristics of the Eastern Mud Minnow?

Though voracious and quarrelsome, it is the most intelligent of our pigmy native fishes, can distinguish certain colors, and is hardy

in captivity, though it likes rather cool water. In an aquarium with other fishes, it will appropriate a corner, driving away all other occupants, and has been known to tear to pieces even its own kind. The body is exceedingly graceful. It will bury in the mud, tail foremost, when alarmed. (See also No. 23.)

756. What are the range and habitat of the Western Mud Minnow (called also Dogfish), *U. limi*?

Through the upper Mississippi Valley, Minnesota, and the Great Lakes region, south of the Ohio River; and more than once it has been unearthed in the half-dried mud of Wisconsin prairies. One would look for it in weedy streams and ditches, in mud and bog-holes, and it lives also in clear creeks with a soft bottom, and in grassy ponds.

757. What are the colors, breeding habits and foods of the Western Mud Minnow?

The color is mottled greenish brown with 14 transverse bars.

March and April are the breeding months and it spawns in very cold water, in which it leaps like a Salmon. The fry are said to develop the air bladder in three days.

Like the Eastern Mud Minnow, this species does not exceed four inches in length.

One-fourth of the food consists of crustaceans and insects (it leaps out of the water for the latter), and Duckweed and filamentous algæ also are favorite foods. In captivity it will accept chopped meat, clams, mussels, flies, confervæ and Duckweed.

The head is narrower, the eye larger and the body fuller than in *U. pygmaea*.

758. What are the characteristics of the Western Mud Minnow?

By a springing motion it can transport itself from one puddle to another. It hibernates in mud to a depth of from four to nine inches, said to be segregated according to sexes.

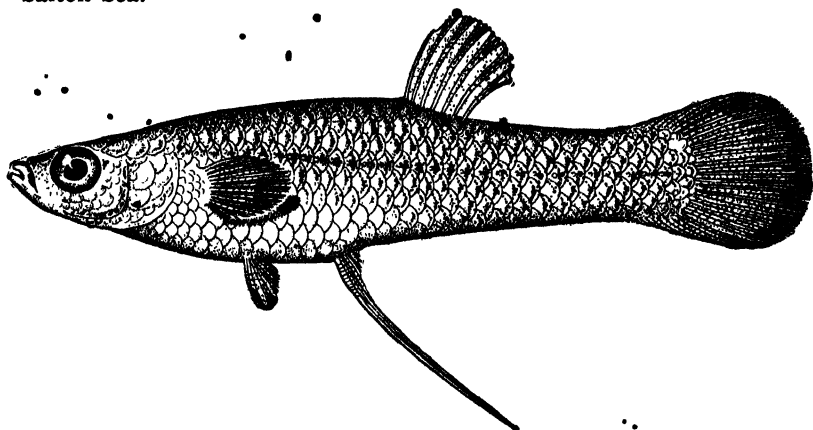
TOP MINNOWS

(FAMILY PÆCILIIDÆ)

759. What are the range and habitat of the Top Minnow or Mosquito Fish, *Gambusia patruelis* (formerly *G. affinis*)?

The normal range is from southern Indiana and Illinois to the Gulf of Mexico and along the coast from Louisiana to Tampico. It is

found in the ditches, marshes and lagoons of the South Atlantic and Gulf States, in lowland, sluggish streams of the southwest, in the lower Mississippi from St. Louis to Louisiana, and the Rio Grande. It has been introduced into Hawaii, Formosa, Germany, Russia, Yugoslavia, Italy, Spain, Palestine, the Philippine Islands and South America for the purpose of destroying malarial mosquitoes, also into California where it now is abundant generally in ponds and streams, in creeks and irrigation ditches in the Imperial Valley, and about the Salton Sea.



Courtesy California Academy of Sciences, Steinhart Aquarium

Mosquito Fish (*Gambusia patruelis*), Male

This Top Minnow, whose normal range is from Indiana to the Gulf of Mexico, has been introduced into California and into many foreign lands to destroy malarial mosquitoes. Males are blue, green, yellow and orange, and about the Salton Sea they assume a rich turquoise blue. Females breed when from three to five months old, 20 to 50 living young being numbered in each batch.

This now is regarded as a species fully distinct from *Gambusia holbrooki*, which is found from New Jersey to Alabama and Florida and represents *G. patruelis* in the Atlantic coast drainage and in the Gulf drainage from Florida to Georgia; but Dr. Carl L. Hubbs believes "it may intergrade with *G. patruelis*." (Bibliography No. 50.)

Fourteen species of *Gambusia* range from Texas through Mexico and Central America, or are indigenous to Cuba, Haiti, the Bahamas, Jamaica or the West Indies generally. They include the Ticky-ticky (*G. melapleura*), very common in Jamaica, the Guajadon (*G. punctata*), also *G. puncticulata*, both of Cuba, the Golden *Gambusia* (*G. nobilis*), also *G. senilis*, which are Rio Grande species, Mann's *Gam-*

busia (*G. manni*) of the Bahamas, *G. dominicensis* of Haiti, Regan's *Gambusia* (*G. regani*) of the Fanuco River in Mexico, and others infrequently seen in the home aquariums of the United States. All are viviparous.

760. What are the colors of the commoner *Gambusias*?

G. paterulis females are gray with dusky bands on the sides, or faintly peppered with black, the males blue, green, yellow and orange. About the Salton Sea they assume a rich turquoise blue. Specimens taken from dark colored swamps are dark green with a purple bar below the eye. Males, which are scarce, average one inch, females one and one-half inches, with a maximum of two and one-half.

G. holbrooki is spotted with black, some individuals being black and white, and sometimes both sexes are jet black. Black females are considered choice.

G. punctata is gray and fawn, with a lavender sheen and tiny red brown spots on the sides. *G. puncticulata* is similarly colored, but reaches only half the length of the former, i. e., females at maximum are one and one-quarter inches, males only about one in-

761. What is the nature of the *Gambusias*?

The disposition of this genus is not of the best. They are quarrelsome as a rule and given to ripping the fins of even larger fishes, which makes them ineligible for membership in the "happy family" community.

They are hardy and commonly last about two years, and have a record of eight years' survival.

762. What are the breeding habits of the Mosquito Fishes?

They bring forth their young alive, breeding when from three to five months old, and though they thrive in cool or brackish waters, spawn only in warm, fresh water. They spawn in Florida or in heated water in the north the year round. Twenty to 50 yellowish fry are numbered in each batch, and broods may be produced at intervals of from four to 10 weeks in a water temperature of from 75° to 80°. The fry, which are expelled in masses of eight to 30, are .37 of an inch long at birth and can swim immediately.

Male *Gambusias* are distinguished by their smaller size and intromittent organ.

763. What are the natural and artificial foods of the Mosquito Fish?

Fish fry, mosquito larvæ, diatoms and filamentous algæ. Like other Top Minnows, it feeds at the surface.

In the aquarium it takes almost anything in the way of standard fish foods, including anchytræids, *Daphnia* and prepared foods. Mosquito larvæ, if procurable, always are a treat. The adults are voracious and will clean up all food thrown in the tank if the pieces are small enough. They will eat the yolk of hard-boiled egg, chopped fish, meat and shellfish. •

764. What are the range and habitat of the American Top Minnow (*Heterandria formosa*)?

It is found in streams from the Carolinas to Florida, in company with *Gambusia*. It may occur also in brackish or salt water.

765. What are the colors and breeding habits of the American Top Minnow?

The sides are dark brownish green, vertically banded with from six to nine dark brown or black stripes made up of small dots. A dark band extends from the mouth through the eye, ending in a black spot at the base of the caudal fin. The dorsal and anal fins bear a black spot at their base, but the other fins are clear.

In this live-bearer the sexes are easily distinguished by the smaller size of the male and his intromittent organ. Young are produced at intervals of three or four weeks, especially during spring and summer, from one to three or more being born every second day over a period of a week or two, at a temperature of 70° to 75°.

This is a hardy, peaceable little fish, which has survived for two and one-half years in captivity.

The foods are the same as those of *Gambusia*. See No. 763.

766. What special interest attaches to the American Top Minnow?

It is the smallest viviparous fish in the world, the male measuring three-fourths of an inch, the female one inch. (The smaller Philippine Gobies are egg layers.)

KILLIES

(FAMILY CYPRINODONTIDÆ)

767. Which Killies are desirable for the fresh-water aquarium?

We have in the United States northern, southern and western fresh-water Killies.

The northern Killie (*Zygonectes diaphanus*), called the Fresh-water Killie, is described under Small Brackish Water Species of the North Atlantic, Nos. 911, 912.

The southern Killies are *Zygonectes chrysotus*, known as the Southern Killifish and Golden *Fundulus*, and *Z. notii*, called the Star-headed Minnow.

The most desirable middle western Killies are the Top Minnow, *Z. dispar*, and the Top Minnow, *Z. notatus*.

The western Killie, which ranges through Nevada and California, is the Desert Minnow (*Cyprinodon macularius*).

768. What is the best food for fresh-water Killies?

A variety of foods is suitable, even prepared fish foods. Raw meat, flies, worms, crustaceans and boiled cereals also are taken.

769. What are the range and habitat of the Southern Killifish or Golden *Fundulus*, *Zygonectes chrysotus*?

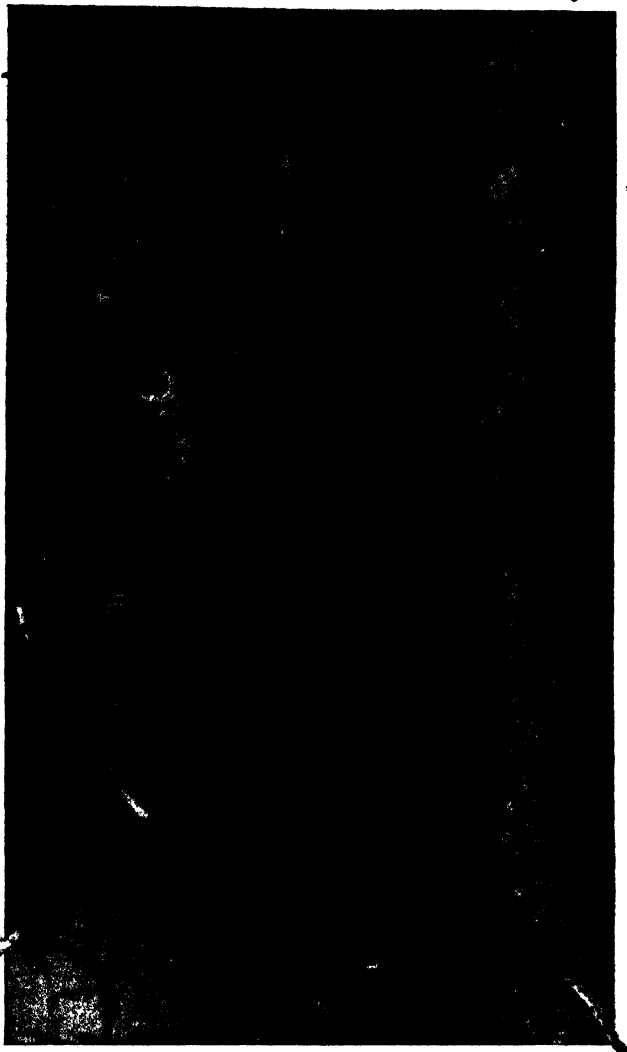
It is common in coastwise streams from South Carolina to Texas, abounding also in Florida. It inhabits swamps, ponds, lakes and creeks, ditches and canals, and is said to enter brackish water.

770. What are the colors and breeding habits of the Southern Killifish?

This species is uniformly brighter than the northern Killie. The back and sides of the male are fish green, belly orange yellow; the body and fins are dotted with rubies, and an emerald glitters on the opercle. The iris is golden and the caudal fin is reddish, the other fins yellow. The female is greenish brown and silver, and her iris is also brown.

This species adapts itself to the temperature of the living room (68° to 72°), and in summer has bred in the north. The eggs are adhesive and hatch in about two weeks. The fry are easy to rear and cared for the same as Goldfishes.

The adults average two inches in length, with a maximum of three and one-half to four inches.



Photograph by Dr. E. Bade

The Southern Killifish (*Zygonectes chrysotus*) is uniformly brighter than the northern Killie. It has bred in the north in summer and the fry are easy to rear. These are typical Killies, with mouths fitted for surface feeding.

771. What are the range and habitat of the Star-headed Minnow, *Z. notii*?

It is found from Florida to Texas in creeks, lakes, ponds and swamps.

772. What is the color of the Star-headed Minnow?

The breast and jaws are orange yellow. On the sparkling silver sides six longitudinal black stripes run from gill covers to tail with 12 to 13 vertical bars more pronounced in the male. The rear of the head is adorned with a star of silver green and a black spot may be observed on the head below the very large eye.

This species averages one and one-half inches in length, with a maximum of two to two and one-half.

773. What are the range and habitat of the Top Minnow, *Z. dispar*?

It ranges from northern Ohio to Illinois, south to Mississippi and west to Missouri, occurring in rivers and lakes, also in sluggish streams, where, Killifish-like, it swims at the surface hunting mosquito larvæ and other insects.

774. What are the colors of the Top Minnow, *Z. dispar*?

The male is banded vertically with about 11 bands, the female horizontally with about nine. Both have black backs and the head is so black as to render the eyes inconspicuous.

This Top Minnow is slightly over two inches long.

775. Where would one look for the Top Minnow, *Z. notatus*?

This species ranges from Michigan to Wisconsin and south to Alabama, Mississippi, Louisiana and Texas, being commonly found in rivers, ponds, canals and creeks, and along the margins of sluggish streams, swimming at the surface in search of insects.

It is one of the handsomest of the Killies, almost the entire body being spotted with fine black dots and a rich black band running from the tip of the snout to the root of the tail.

The average length is three inches, with a maximum of three and one-half.

776. Where is the Desert Minnow (*Cyprinodon maculatus*) found?

This little fish, which is a fresh-water cousin of the Sheepshead Minnow, lives in large numbers in the springs and streams of the

desert, from southern Nevada to Sonora, California. Often it is found in Artesian water and desert water holes in southwestern California. It swims in dense schools along the shore of the Salton Sea. The scientific name means Spotted Tooth Carp.

777. What are the colors and breeding habits of the Desert Minnow?

The color varies with locality, but often the body of the male is an iridescent electric blue, and his sides are mottled with indistinct brown markings. The fins are red, edged with greenish blue, except for the pectorals, which are transparent. Females, which are slightly larger, are brownish green with large silver spots on the gill covers and a black streak along the lateral line from the center of the body to the tail.

A maximum length of about two inches is reached, most specimens averaging less.

The pale yellow eggs, measuring 1 mm. in diameter, are attached to the roots of floating plants such as Duckweed, and in the aquarium it is well to remove the adults after spawning is over, as they begin to fight.

778. What are the characteristics of the Desert Minnow?

The Desert Minnow is equally at home in the aquarium and in the garden pool, and as in its natural habitat the temperature runs to such extremes as 65° and 128°, it is not affected by drastic changes, but will survive for over three years in a garden pool where the temperature ranges from 53° in winter to 95° or higher in summer, and in the aquarium is as happy at 64° as at 80°.

Its natural food consists of algæ and aquatic insects, and it is valuable as a mosquito destroyer and a most desirable adjunct to the western garden pool.

CATFISHES

(FAMILY AMEIOURIDÆ)

779. Which North American Catfishes are most desirable for the home aquarium?

Several species do well in the home aquarium, are safe with goldfishes and most native fishes, and make most interesting pets, though their sharp spines sometimes injure other animals in small quarters, particularly tadpoles which heedlessly rest themselves against the spines and become fatally scratched. Native Catfishes have

lost favor more or less of recent years, the South American dwarf Catfishes having supplanted them as scavengers in the toy tropical aquarium, though the northern Cats still are kept with Goldfishes in aquaria and pools.

The common Bullhead (*Ameiurus nebulosus*), called the Horned Pout in Massachusetts, though not the smallest, the smaller Black Bullhead (*A. melos*) which ranges from New York to Kentucky and west to Nebraska, the Stone Cat (*Noturus flavus*), and the Mud Catfish or Tadpole Cat (*Schilbeodes gyrinus*) are among the commonest of small size.

780. What are the characteristics of the Catfishes?

Whiskerlike barbels around the mouth, which give them their name, and the ability to inflict an injury with a sharp spine located at the base of the pectoral fin, are their main characteristics. They guard their young and are entertaining in the home aquarium, though they do not breed there.

A common Bullhead observed by Miss Mellen amused itself by circling around a sprig of *Anacharis*, repeating this performance every day as a regular diversion, always approaching the plant from the left of the tank. Its revolutions were counted and it was found that the fish encircled the plant an even number of times more often than an odd number. (Bibliography No. 207.)

781. Where is the Bullhead, *Ameiurus nebulosus*, found?

From Maine to Texas and Florida. Nearly 60 years ago it was introduced into various western rivers where it has become exceedingly abundant, notably in California, New Mexico and Arizona. It lives commonly in ponds, lakes and the "dead waters" of streams. In California it is called the Sacramento Cat.

782. What are the colors and spawning habits of the Bullhead?

Generally this fish is yellowish brown or black. In the Susquehanna, black specimens marked with lemon and white are found, and albinos have been taken in New Jersey.

Parental care often has been observed in this species. According to Anna B. Comstock, both parents clear the pebbles from the chosen nesting place, sucking the pebbles into their mouths and carrying them some distance; but the male is more active in guarding the nest and seeing that the eggs are aerated, using his snout to bring to the top those that are on the bottom of the mass.

In the Bullhead, eight barbels surround the mouth. In native



Courtesy California Academy of Sciences, Steinhart Aquarium

Small specimens of the Bullhead, called the Horned Pout in Massachusetts and the Sacramento Cat in California, are suitable for the home aquarium, and from them one may learn new things about fish psychology.

waters it grows one and one-half feet long, with a weight of four pounds, and makes a good aquarium species only when of small size. It is extremely hardy, and, as every boy knows who has fished for it, the Bullhead can inflict a painful wound.

783. What are the range and habitat of the Stone Catfish, *Noturus flavus*?

The Stone Cat is widely distributed through the eastern states, the Great Lakes region, south and west to Texas, Wyoming and Montana. It lives under stones on the clean bottoms of brooks, rivers and channels.

784. What are the colors and breeding habits of the Stone Cat?

It is yellowish brown, blackish above and with fins edged with yellow, and reaches a length of one foot maximum, though averaging five or nine inches.

It breeds in June and July, laying its orange yellow eggs in batches fastened to the under sides of stones.

It is called the Stone Cat because it lies for hours on one side as though "dead as a stone."

Stone Cats have a poison gland at the base of the pectoral fin

which adds an extra sting to the wound and causes an extremely painful sore, which, however, is not dangerous.

The Stone Cat is distinguished by the adipose fin which is flatly joined to the back.

This Catfish preys on other little fishes and insects and crustaceans large and small.

785. What are the range and habitat of the Tadpole Cat or Mud Catfish, *Schilbeodes gyrinus*?

This species is common in the latitude of New York, through the Great Lakes region and the Mississippi Valley, living in lakes, creeks, rivers and small brooks. There are three species of Tadpole Cats or Mad Toms in Kentucky and Tennessee.

786. What are the characteristics of the Tadpole Cat?

It has a poison gland similar to that of the Stone Cat, inflicting a painful but not dangerous wound. It is exceedingly tenacious of life.

To distinguish it from others requires a close inspection, the distinguishing feature being the more strongly developed pectoral spines.

This species spawns in May.

The adult length is eight inches maximum, most specimens averaging from three to five inches.

The natural food consists principally of crustaceans and insect larvæ. In the aquarium it will take chopped clams, mussels and shellfish.

THE PIRATE PERCH

(FAMILY APHREDODERIDÆ)

787. What are the range and habitat of the Pirate Perch or Mud Perch, *Aphredoderus sayanus*?

It is a common little fish in coastwise swamps and sluggish streams and bayous from New York (including Long Island) to Texas, and in the Mississippi Basin and Louisiana north to Michigan and Minnesota. Both fresh and brackish waters suit its taste, and it is found in the tide-waters of the lower Delaware.

788. What are colors and breeding habits of the Pirate Perch?

The color is olive, speckled, and with two black bars at the base of the caudal. The iris is brown. The lateral line is weak or wanting, the tail is square and the under jaw projects.

Spawning takes place in May.

The nest is made among the vegetation, and both parents are said to remain on guard until the fry are one-third of an inch long. This species has not bred in captivity.

The adult length is five inches maximum, with an average of three and one-half.

Living-room temperature suits it perfectly—68° to 72°

789. What are some interesting facts concerning the Pirate Perch?

It has no relatives, being the only member of its family. It is voracious, remaining concealed in thick vegetation by day and foraging largely by night. The air vessel is large and adherent to the abdominal walls. It has some small teeth, but the principally interesting feature about the fish is the unique change in its physiology as it matures. The specific name, *sayanus*, is from the naturalist, Thomas Say. The generic name, *Aphredoderus*, means "excrement-throat" and relates to the vent, which in the young lies behind the ventral fins and as the fish grows, moves forward until in the adult it is situated at the throat, just below the preopercle.

790. What are the natural and artificial foods of the Pirate Perch?

Insects constitute 90% of its food, the remainder being made up of crustaceans, worms, algæ and fish fry. It was named Pirate Perch by Dr. C. C. Abbott because in his aquarium the only food taken was other fishes.

It prefers meat, fish and shellfish. Any live food that is available will be appreciated, though all foods should be offered at nightfall, to prevent decomposition before the fish leaves its lair among the plants search for its dinner.

It will last for upwards of two years in captivity.

FRESH-WATER STICKLEBACKS

(FAMILY GASTEROSTEIDÆ)

791. Which Sticklebacks are found in fresh water in the United States?

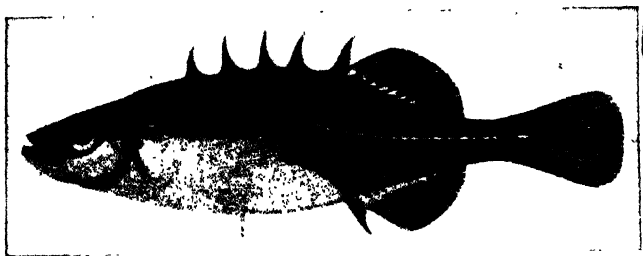
The Brook or Black Stickleback (*Eucalia inconstans*) is common in New York, also Canada, the Great Lakes region, and from Ohio west to Kansas and Montana. A Lake Superior species (*E. pygmaea*)

vividly colored, may be found in company with the plainer nine-spined Sticklebacks, the commonest of which *Pungitius pungitius*, appears also in Europe. The Three-spined Stickleback is common in the fresh waters of California.

Their nest-building habits have won the Sticklebacks a place in numerous aquaria in homes and schools. Economically they have been noticed as great destroyers of Trout and Salmon eggs.

792. What are the breeding habits and colors of the Brook Stickleback?

The male in spring is jet black, tinged anteriorly with red, the female greenish, mottled and with 10 cross bands. The male builds a nest and defends the young vigorously. With a sticky secretion from



From *The Fishes of Illinois*, by Forbes and Richardson

The Brook or Black Stickleback (*Eucalia inconstans*)

The nest-building habits of Sticklebacks of both fresh and brackish waters have won them a place in numerous aquaria in schools and homes. They are quarrelsome and unhesitatingly attack fishes much larger than themselves. In this species, which is said to be the only five-spined Stickleback, males in spring are jet black, tinged anteriorly with red. The average length is 0.7 and one-half inches.

his kidneys he glues together bits of algæ and plant stems to form the minute round nest, which has two openings and is attached to some aquatic plant. The eggs of several females may be deposited in one nest. The fry are fish green like the mother.

The adult length is one and one-half inches, though occasional specimens reach two and one-half inches.

793. What are the characteristics of the Brook Stickleback?

For the aquarium the Brook Stickleback is the favorite among fresh-water Sticklebacks. It inhabits small, clear brooks and ponds, and sometimes is found in stagnant water.

It is a quarrelsome little fish, always on the alert to attack small fishes and sometimes destroying larger fishes. On its back is a row of three or four free spines with a fifth at the beginning of the dorsal, and it is said to be the only five-spined Stickleback.

It is one of the hardiest of the Sticklebacks and has lived four years in captivity.

It is a bottom feeder, living on filamentous algæ, crustaceans (particularly Cypris), and insects.

794. What is the range of the Nine-spined Stickleback (*Pungitius pungitius*), called also the Ten-spined Stickle?

This little fish is found on both sides of the Atlantic. In America it extends from the Arctic to Long Island, is abundant in the Great Lakes (particularly Lake Superior) and their tributaries north to Alaska. In the latitude of New York, it lives in brackish water vegetation and along the shallows, though it is found also in fresh water.

In Europe, it is common in France, where it is called Epinoche; also in Germany, Scandinavia and Great Britain. It lives in North Sea and Baltic estuaries, also in rivers, but displays a preference for small tributary streams far up from their course. It occurs in most of the lakes and rivers of Sweden, where pigs are said to feed upon it.

795. What are the colors and habits of the Nine-spined Stickleback?

It is quite variable in color, commonly a fish green with silver below, and barred with from six to 10 bands. The iris has a metallic luster. Both sexes are reddish in the breeding season, which occurs in early summer. The body is slender and has eight or nine free dorsal spines, the ninth, sometimes a tenth, forming a spine at the beginning of the dorsal fin.

The male generally builds a nest shaped like that of an oriole, and the orange eggs hatch in 12 days.

Adults average about two and one-half inches, with a maximum length of three.

Insects and crustaceans form the principal foods.

This species is very sociable and gathers in large schools, but the males are fierce fighters.

In captivity the Nine-spined Stickleback has survived for two years.

SILVERSIDES

(FAMILY ATHERINIDÆ)

796. What are the range and habitat of the Brook Silverside (*Labidesthes sicculus*)?

It ranges from Lakes Ontario and Michigan to Iowa, Florida and Texas, having adapted itself to all sorts of fresh waters—clear streams and sluggish rivers, clear lakes and muddy lowland lakes, ponds and swamps. In West Virginia it is known also as the Skipjack.

797. What are the colors and foods of the Brook Silverside?

This is a graceful, swift, silvery little fish, with long body, "slender as a Pike," pointed snout and large eyes. These are two dorsal fins, the first being small and rounded, the second large and square. The anal is much larger than the ventral fin, and the caudal is forked. A black lateral line extends from the gill cover to the root of the tail, and the sides, which are semi-translucent, are decorated also with horizontal stripes of brilliant silver. The length is three and one-half inches.

The Brook Silverside is delicate and difficult to transport. Its natural foods consist of minute water animals—crustacea, insect larvæ, aquatic worms and snails.

DARTERS

(FAMILY ETHEOSTOMIDÆ)

798. Are Darters easy to maintain in captivity?

Darters are accustomed to cool water, therefore it is difficult to maintain them in captivity except in running water or in aquaria supplied with mechanical aeration. Under these special conditions, they will survive for two or three years.

They can be kept in a "happy family" tank, being inoffensive to other species.

799. Where would one look for Darters?

They will be found darting quickly about in the currents of swift, rocky streams. In lakes and slower streams they frequent the bottom, sometimes conceal themselves under stones, and may lie motionless for a considerable period.

Which Darters may one find who goes hunting for them?

More than 100 kinds of Darters are found in the United States. Many lakes and rivers are inhabited by Darters found nowhere else.

The Black-sided Darter (*Alvordius maculatus*)* abounds from Pennsylvania to South Dakota, and is common in the Ohio Valley.

Probably the best known of all Darters is the Johnny Darter (*Boleosoma nigrum*) of the eastern states, ranging from New England and New York as far west as Colorado.



From *The Fishes of Illinois*, by Forbes and Richardson

The Green-sided Darter (*Etheostoma blennioides*), recorded from New York to Kansas and South Dakota and as far south as Alabama, is called "the most simply beautiful of all fresh-water fishes."

Others are the Fusiform Darter (*Boleichthys fusiformis*), found from Massachusetts south in coastwise streams; the Blue Johnny or Rainbow Darter (*Oligocephalus caeruleus*), ranging from New York to Michigan and Kentucky and through the upper Mississippi Valley; the Tessellated Darter (*Boleosoma olmstedii*), running from Lake Ontario to Massachusetts and south to North Carolina; the Tassel-lated Darter (*B. efulgens*), found from Maryland to North Carolina; the Fantailed Darter (*Catnotus flabellaris*), taken from New York to South Carolina and Kentucky and west to Iowa; the Green-sided Darter (*Etheostoma blennioides*), recorded from New York to Kansas and South Dakota and as far south as Alabama. This Darter abounds in Illinois, and in the Ohio and Tennessee Rivers. The Blue-breasted Darter (*Nothonotus camurus*), abounds from Lake Erie to Tennessee in clear, swift waters. The smallest of the Darters, called the Least

Darter (*Microperca punctulata*), is found in Indiana, Michigan, Tennessee, and south to Arkansas. (Bibliography No. 81.)

There are 16 species of Darters in Texas, 27 in Kentucky and Tennessee.

801. What are the spawning habits of the Darter

All Darters spawn in the spring, as far as known. Darters seldom have bred in captivity, and their spawning has been little observed, but Mr. W. P. Seal some years ago was fortunate enough to witness the spawning of the Tessellated Darter. The eggs are adhesive and are laid singly on the under surface of stones. The male, arrayed in a coat of brilliant hue, defends his nest with a vigor and belligerence that almost matches these qualities in the Sticklebacks. It is said that the Johnny Darter does not guard its eggs, but that the Fantailed Darter remains near the nest until the young have hatched.

802. What is the food of the Darters?

Small crustaceans, insects—especially midge larvæ, and other live water animals, but in captivity they take a variety of foods including chopped meat, fish and shellfish.

803. What are the characteristics of Darters?

They climb and jerk and dart about like birds instead of swimming smoothly like most other fishes. This is not due to the absence of an air bladder as is generally supposed, although the air bladder is a rudimentary affair. Darters have the ability to turn their heads, a curious feature seldom found in fishes. They lie on the bottom of a tank with their heads raised like lizards. They can also wink. Jordon and Copeland, eminent ichthyologists, say that Darters can "outwink all animals in creation except owls." They are exceedingly playful. Though so small they represent to the scientist the perfection of form in a fish, "concentrated rather than dwarfed."

804. Which Darters are hardy?

The Black-sided Darter, of which it is said that it is "hardier than any other fish that is so pretty and prettier than any other that is so hardy," and the Fantailed Darter, which is called "the Darter of Darters, hardiest, wiriest, wariest of them all," share the honors in respect to hardihood. The Rainbow Darter, with a maximum length of two inches, has proved sufficiently adaptable to breed in captivity, spawning occurring in June and the eggs being deposited among pebbles. Its colors are blue and scarlet.

805. What are the colors of the Black-sided Darter?

The handsome orange body is marbled with black, and a vertical stripe runs through the eye.

It is called "the fine gentleman of the family" and is not so jerky nor so delicate as many of its relatives.

806. What is a Sand Darter?

There is only one Sand Darter, *Ammocrypta beanii*, which ranges from Illinois southeast through the Gulf States and from Alabama through Mississippi and Louisiana, usually in clear, sandy streams.

This species spends most of its time in the sand with only its eyes showing, and can bury itself in a few seconds.

The scales are translucent with fine black dots.

Like that of various other Darters, its food consists of dipterous larvæ, mainly Chironomus and the larvæ of May Flies.

807. Where would one look for the Johnny Darter (called the Black Minny in Kentucky and Tennessee)?

It is found commonly among gravel and weeds on the bottom of clear, small brooks. (See also No. 800.)

808. What are the colors and habits of the Johnny Darter?

Normally it is a yellowish brown, freckled, with seven or eight W-shaped marks on the side. In the breeding season the head of the male becomes jet black, this color sometimes extending to the tail. The first dorsal spine becomes swollen and club-shaped at the tip. It is called "Beautiful as a wood warbler."

It spawns from the last of April to the first of June.

A length of from two and one-half to three inches is attained by this species, which is distinguished from others by a slight interruption of the lateral line behind.

It has a habit of leaning forward over stones, resting on its front fins and looking very froglike; also it strikes birdlike attitudes. It is fond of concealing itself partly in sand. It is an active and interesting little fish.

SUNFISHES

(FAMILY CENTRARCHIDÆ)

809. What are some interesting facts about Sunfishes?

The family is a large one and found only in North America. Most species are voracious and quarrelsome, also very beautifully colored

and worth keeping in an aquarium if they can be kept by themselves. They are easy to maintain.

Sunfishes have bred in captivity.

810. What are the natural and artificial foods of the Sunfishes?

The natural foods are worms, spails, crustaceans, larvæ of mosquitoes and other insects, small fishes, and small plants such as Duckweed, confervæ and other algæ.

Sunfishes dislike dry fish foods, though they will accept them if nothing else is available, as well as hard-boiled egg yolk and other Goldfish foods. The best foods are chopped raw fish and shellfish, beef, lamb, liver, live flies, mosquito wrigglers, *Daphnia* and other small crustaceans, wax-worms and enchytræids.

811. Which of the Sunfishes can be kept together?

The Peacock Sunfish, the Spotted, Diamond or Blue-spotted Sunfish, the Little Sunfish, the *chætodon* or Black-banded Sunfish, the Everglades Pigmy Sunfish, and the Orange-spotted Sunfish.

812. Where would one look for the Peacock Sunfish (*Centrarchus macropterus*)?

This species, called also the Flying Perch, Long-finned Sunny, Many-spined Sunny, Round Sunfish, and Flier, lives in lowland streams and bayous, and ranges from Virginia south to Florida and Louisiana, and north through the Mississippi Valley into southern Illinois.

813. What are the colors and breeding habits of the Peacock Sunfish?

It is green. A series of dark brown spots on the sides, below the lateral line, forms interrupted longitudinal lines. There is a dark spot, below the eye, and the soft dorsal and anal fins are reticulated. In young specimens, there is a conspicuous eye spot at the base of the soft dorsal, which disappears in the adult.

This species breeds in June, July and August. Like many other Sunfishes, it sweeps a depression in the sand or gravel with its fins and snout, and there the eggs are laid. The male takes care of the eggs which hatch in about three days, and watches over the fry.

Adults average three inches, with a maximum of six.

The temperature of the water generally and also for spawning should be 68° to 75°.

This is an ideal aquarium fish, good also for the garden pool.

Insects, worms, shellfish (including snails and fresh-water shrimps) form the natural foods. In the aquarium it will accept almost any prepared food, and is fond of dried shrimps.

Under favorable conditions it will last for three years.

814. Where would one look for the Diamond Sunfish (*Enneacanthus gloriosus*)?

This Sunny, called also Spotted Sunfish and Blue-spotted Sunfish, is found commonly through the Atlantic coast states from New York to Florida. It lives among the vegetation at the margins of ponds, lakes and streams, in clear, still water, and also enters brackish water near the mouths of streams about Chesapeake Bay.

This is an exceedingly beautiful little fish. The body is set off with many silvery blue spots forming definite horizontal lines. In the female, the blue spots are fainter and sometimes wanting. Both sexes have a dark spot just below the eye.

Four inches is the maximum length.

815. How can one breed the Diamond Sunfish?

The eggs are laid among aquatic vegetation and hatch in a couple of days. The adults eat them if they are not removed at once.

816. Where would one look for the Little Sunfish, *Enneacanthus obesus*?

Its range is from Massachusetts south to Florida, where it lives among the water plants in creeks and rivers.

It attains a length of three inches, and is distinguished from the Diamond Sunny by the presence of seven or eight wide, rather inconspicuous vertical bands, and a round black spot on the gill cover on a level with the eye and of the same size as the eye.

817. Where would one look for the *chætodon* or Black-banded Sunfish (*Mesogonistius chætodon*)?

The *chætodon* is found from Maryland north to New Jersey, in sluggish streams, ponds, creeks and rice ditches. Often it is taken in the cedar swamps of New Jersey, where it was discovered in 1854. It has a habit of clustering on the submerged leaves of water plants.

818. How can the *chætodon* be bred?

The *chætodon* has been bred in a community tank with toy tropicals such as Guppies, *Barbus*, *helleri* and Platys. The eggs, numbering

upward of 100, are laid in June among the plants and hatch in from two to five days at a temperature of 66°. The fry hang on the vegetation for the first few days, and at five weeks are exact miniatures of their parents, one-half inch in length. They will eat egg yolk, enchiræids and chopped earthworms.

819. What are the colors of the *chætodon*?

The *chætodon* easily is the aristocrat of the tribe, a large-eyed exquisite creature with pearl-gray body vertically striped with six or eight black bands, and ventral fins of black and orange. The iris is brown.

A maximum length of three to four inches is reached.

It is a graceful swimmer of gentle disposition, not too hardy, though with proper food it will live three years in captivity, and one specimen is said to have survived for 10 years. A singular fact about the *chætodons* is that when grouped they do not do as well as when one or two specimens are placed in a tank by themselves or with other species.

820. What are the range and habitat of the Common Sunny or Pumpkin Seed?

The Common Sunny (*Eupomotis gibbosus*) extends from Florida north to Maine and west to Minnesota. Its services as a mosquito destroyer are generally in demand in house ponds, and it was acclimatized in Europe some years ago.

It frequents clear brooks and ponds, preferring still waters, and is found in company with Shiners, Minnows, and Killies. It has no aversion to mud, however, and may be found in ditches and muddy creeks.

821. What are the colors, nesting habits and foods of the Common Sunny?

It is a beautiful fish, the body glistening as though set with gems—emeralds, and blue and yellow topazes predominating, with glints of garnet in the eyes, and a ruby near the edge of the gill covers. Two hundred years ago the Common Sunny was called "Round Robin" and an early observer remarked that it looked "like a brilliant coin fresh from the mint." The male has conspicuous ear flaps, luminous borders on his fins, and his dorsal and caudal fins are a brighter blue than those of the female.

This species breeds in May and June. A depression several inches deep and a foot across is hollowed in the mud with the fins. Some say only the male, others assert that both parents guard the nest with great spirit. According to Ann H. Morgan (who believes only the male guards the eggs), the spawning pair circle together over the nest, "their ventral sides close together, while eggs and clouds of sperm cells are discharged into the water." The eggs are adhesive and attach to stones and gravel in the nest, and the young are left to fend for themselves. They reach a length of one and one-half inches in five months.

The adults attain a maximum length of eight inches, but most specimens average only six inches.

This Sunfish is quarrelsome by nature and best kept with its own kind.

The natural food of the Common Sunfish consists of mollusks 50%, insects 20%, crustaceans 20%. It eats also worms and fish ova. It is fond of the eggs of the Bowfin.

It is a hardy species and has survived four years in running water.

822. Where is the Green Sunfish (*Apomotis cyanellus*) found?

This beautiful fish has a very wide range east and west, being found from the Great Lakes region to Mexico, abundantly from Ohio westward to the Rio Grande. It is very common in the Mississippi Valley. In Louisiana it is called the Blue-spotted Perch. It is known also as Blackeyes, Little Red-eye, Blue-spotted Sunny and Blanco Perch. It has been introduced into California. It is the common Sunfish of the west, the Pumpkinseed being the common Sunfish of the east.

823. What are the colors and foods of the Green Sunfish?

The colors are extremely variable, but, as the various common names indicate, the species often shades from blue green to rich green. The general color is emerald with a brassy luster, yellow beneath, and with blue-spotted scales. The iris is red and there are blue stripes on the cheeks.

This species reaches a maximum length of seven inches.

In a state of nature, only animal food is taken, and this consists of one-third of fishes, the remainder being made up of insects and crayfishes. When small, it eats small crustaceans, mosquito larvæ and fish fry.

In captivity it accepts any food offered.

824. What is the range of the Scarlet Sunfish or Red Perch (*Sclerotis miniatus*)?

This Sunfish ranges through the Mississippi Valley, southern Illinois to Louisiana and Texas, favors swamps and ponds, but is common also in rivers.

825. What are colors and habits of the Scarlet Sunfish?

The basic color is dark olive, and the sides below the lateral line are striped with seven or eight rows of bronze or purplish spots. The belly is lighter, with a brassy luster. The upper part of the head is dark, the gill covers bluish green, and the ear flap is black with silvery upper and lower margins. The soft dorsal and anal fins are reddish brown, the caudal reddish with a light edge, and the iris is red. Specimens taken from swamps are redder. This Sunfish is not very abundant.

Spawning occurs during May and June.

It reaches a length of four inches.

Its habits are the same as those of other North American Sunfishes.

826. Where is the Red-breasted Sunfish (*Lepomis auritus*) found?

This Sunfish ranges from Maine to Virginia, and is abundant in all streams east of the Alleghanies and south of New York. It is particularly common in the Delaware and its tributaries.

It has at least 30 other common names, most familiar of which are Tobaccobox, River Sunfish, Yellowbelly, Long-eared Sunny, Red-headed Bream, Red-bellied Robin and Horned-eared Sunfish.

827. What are the colors of the Red-breasted Sunny?

The colors are evanescent. Generally the scales are blue with red spots, overlying a fish green, and below the color is orange red.

A long, tough opercular flap gives the names of Long-ear and Horned-ear.

A maximum length of eight inches is attained and only young specimens are desirable for the home aquarium.

The habits, foods and disposition are the same as those of the Common Sunny.

This species has survived for three years in running water.

828. What is the range of the Long-eared Sunfish, *Xenotrichus megalotis*?

This Sunfish, called also Red-eyed Sunny, Small Green Sunfish and Brilliant Sunfish, ranges from Michigan to Minnesota, South Carolina and southward to the Rio Grande.

829. What are the colors of the Long-eared Sunfish, *X. megalotis*?

The colors are evanescent, commonly green or brown above, sometimes robin's egg blue or deeper green on the sides, mottled with innumerable transverse luminous dots. Below the eye, the colors vary from straw to ruby red, and a ruby glitters in the iris.

The "ear flap" is long, "thumb marked" before and red behind.

The disposition, habits and foods are the same as those of the Common Sunny.

This Sunfish has survived for three years in running water.

830. What is the range of the Mud Sunfish (*Acantharcus pomotis*)?

It is found in sluggish streams near the coast from southern New York to South Carolina.

Other names are Bass Sunfish, Mud Bass and Mud Perch.

831. What are the colors of the Mud Sunfish?

The color is dark greenish, with five indistinct black longitudinal bands along the side. The fins are dusky, and a black spot is present on the operculum.

The maximum length is six inches.

Young specimens make good balanced aquarium fishes. Any food offered is accepted, and this species has survived for two and one-half years in captivity.

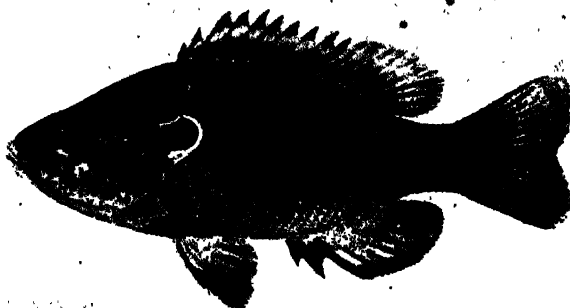
832. Where would one look for the Orange-spotted Sunfish (*Allotis humilis*)?

This showy little fish, called also the Red-spotted Sunny, favors creeks, small rivers and lowland lakes, and in Illinois and the Mississippi Valley may be found in company with the Green Sunfish. Its range is from Ohio and Kentucky southwest through Arkansas and Texas, and northwest through Kansas, the Dakotas and Minnesota. It is abundant in the Missouri and Ohio basins.

1001 QUESTIONS ANSWERED

833. What are the colors and breeding season of the Orange spotted Sunfish?

This Sunfish wears a light olive coat sprinkled with fine dots of gold and emerald, the belly is deep orange dusted with brown, and the sides are ornamented with 20 or 30 orange spots, deep and bright in males, brownish in females. In the males, the spinous dorsal bears a narrow edge of crimson, and the soft portion has a wide margin of orange, while the ventral and anal fins are orange or crim-



From *The Fishes of Illinois*, by Forbes and Richardson

The Orange-spotted Sunfish (*Allotis humilis*) reaches a maximum length of three and one-half inches and is one of the most brilliant of North American fresh-water pigmy fishes.

son. The male's forehead is concave, his profile steeper, and his ventral fins are longer than those of the female.

The maximum length is three and one-half inches.

Spawning occurs in early summer (in June in Illinois), but this Sunny has not yet bred in captivity.

It is not a pugnacious species, does well with other peaceable fishes, and will survive for nearly three years in the aquarium. It is a good species for the garden pool.

MILLER'S THUMBS

(FAMILY COTTIDÆ)

834. How many Miller's Thumbs are there?

Thirty species with somewhat similar colors and habits are found from New York to California, and from Maine to Georgia, the best known in aquariums being the Fresh-water Sculpin or Little Stargazer (*Cottus gracilis*).

835. What are the characteristics of the Miller's Thumbs?

They are the only fresh-water Sculpins, presumably descending from an Asiatic marine type. The top of the head is warty, the skin velvety, except for sharp prickles behind the pectorals. They can erect their spines and swell out their grotesque heads when annoyed. The name is derived from the broad, flat skull, resembling the shape of millers' thumbs which became flattened from testing flour.

836. What are the breeding habits of the Miller's Thumbs?

They breed during spring and summer, the eggs of most if not all species being laid in masses attached to the under surfaces of stones in shoal water. Usually the male guards the nest for one month.

837. Where would one seek the Miller's Thumbs?

They are taken in most streams and lakes where Trout occur and often lie on the bottom under rocks or secrete themselves among the weeds.

838. What is the range of the Miller's Thumb, Fresh-water Sculpin or Little Stargazer (*Cottus gracilis*)?

It is found from Maine to New York, also in the tributaries of the Delaware and Susquehanna.

839. What are the colors and foods of the Miller's Thumb or Little Stargazer?

The fish is brown, and its yellow eyes have dark blue pupils. It changes color from fright or lack of oxygen, turning gray within five minutes.

Most specimens found are about four inches long, though a maximum of seven inches may be reached.

Normally its food consists of 40% of aquatic insect larvæ, 35% of crustaceans, and 25% of small fishes. It hides under stones and darts out at its prey. Like the Sticklebacks, it preys on the eggs of Trout and Salmon and is of economic importance in that respect.

SURFFISHES

(FAMILY EMBIOTOCIDÆ)

840. What are the range and habitat of the *traski* or Trask's Perch (*Hysterocarpus traski*)?

It is common in the rivers and ponds of central California, and ranges through the Sacramento Valley from Lake County to Santa Clara County.

241. What are the colors and breeding habits of the *traski*?

The females of this species are more strikingly colored, green bodied, with bright yellow belly and throat, darker on the back and with black blotches forming irregular transverse bars on the sides. The males have dark brown backs, with silvery or yellow sides, showing fine dark spots at times.

The *traski* is the only fresh-water species of this family of live-bearing Perches, and is believed to have lived formerly in the sea. It has not bred in the home aquarium, but in the garden pool young



Courtesy San Francisco Aquarium Society

Trask's Perch or *traski*, Female

This is the only fresh-water species of the family of Surffishes or live-bearing Perches, and though the average length of the adult is only four inches, maximum six, the young at birth measure one and one-half inches and number from 12 to 20 in each litter. The females are more brightly colored, green-bodied, with bright yellow belly and throat.

are born in the spring. They are one and one-half inches long at birth, number 12 to 20 in each litter, and are fully able to take care of themselves.

The maximum adult length is six inches, most specimens measuring only three and one-half to four.

The *traski* favors alkaline water and requires plenty of room to swim. A temperature of from 65° to 72° will keep it in good condition, though it can stand a lower temperature.

The natural food consists of small crustacea, insects and algæ. In captivity it takes all foods offered, and will survive for about two years. Its disposition is mild.

THE SLEEPERS

(FAMILY ELEOTRIDÆ)

842. What are the range and habitat of the Sleeper or Spotted Goby (*Dormitator maculatus*)?

It ranges from South Carolina to Panama, the West Indies and Brazil, and is found also on the Pacific Coast and West Coast of Mexico and Central America, in fresh and brackish water. In captivity it thrives better in a fresh-water balanced aquarium than in brackish water.

The young are abundant in muddy puddles left by winter rains or by high tides.

843. What are the colors of the Sleeper?

It is celebrated for its lovely colors—rich shades of blue and yellow on the sides and fins, with backs a blend of emerald and rock brown. There are two dorsal fins and the body has the shape of a small Carp. The male is not only more richly colored, but his dorsal fins are closer together than those of the female and all his fins are larger.

Room temperature, 68° to 72°, is suitable for the Sleeper. It has not bred in captivity.

844. What are the characteristics of the Sleeper?

It remains motionless for long periods, resting against the glass, or plants, or balancing itself at the top, as though asleep. Also, it has a habit of fainting (said to be confined to the males) when first taken into captivity, if people move before the tank or disturb the water. Some die from fright, but as a rule the fainter recovers after lying on its back gasping for a few minutes. Specimens well acclimated to captivity do not faint.

This species has an added disadvantage of growing too large for the home aquarium, and only young specimens are desirable. In tropical waters it is taken as a food fish. It is said to attain a length of two feet or more in a state of nature. Aquarium specimens measure about four or five inches.

In nature it swallows much mud and vegetation. In the aquarium it is a ravenous eater of aquatic plants, beef, shellfish and fish.

The Sleeper will survive in captivity for upwards of 26 months.

845. How is the Sleeper, *Dormitator thaculatus*, distinguished from *D. latifrons*?

The latter name was given the first specimen of Sleeper found on the California coast, and the two species are the same. The Sleeper known as *D. latifrons* ranges along the Pacific slope from lower California to Ecuador. The colors of the two are similar except that the transverse markings of the *Dormitator* give place to dots in the *latifrons*.

846. What are the range and habitat of the Sleeper or Guavina, *Eleotris pisonis*?

This species ranges from southern Florida to Brazil, is found in streams of the West Indies and in brackish water about Bermuda. In Colombia it lives in the Gaira River. Mr. Guppy records it as one of the mosquito-destroying species of Trinidad. It was first discovered in Brazil in 1648 but still is uncommon in North American waters.

Eleotris means bewildered, and probably refers to the state of mind of Gronovius when he named the fish *Eleotris capite pluteo*. (This was before the binominal system came into existence.) For more than 100 years, the Sleepers were classified as Gobies, but later authors reached a definite decision that *Eleotris* and *Dormitator* are not Gobies.* (See Goby, No. 873.)

The specific name is from Dr. Pison, a traveler.

847. What are the colors of the Guavina?

It is somewhat darker than the Sleeper (*Dormitator*), in color brown or black, and has alternate rows of light and dark lateral dots. The fins show dark wavy lines. It is a smaller species than *Dormitator*, attaining a length of only half a foot.

848. Which are the best specimens of northern native fishes for a community or "happy family" tank?

Darters are of easy disposition, also Suckers, Roaches, Dace, Killies and most Minnows.

849. If one goes collecting wild fishes, what is the chief thing to be remembered?

Not to take home too many. The eye always is larger than the aquarium.

* We are indebted to Mr. H. Walton Clark for this information.

THE SALT-WATER AQUARIUM

GENERAL INFORMATION

850. Is a salt-water aquarium worth while?

One of the chief attractions of the salt-water aquarium is the brilliant fish of larger size. The salt-water aquarium also affords an opportunity to enjoy a much wider variety of animal life than is possible with a fresh-water aquarium, and when one becomes expert enough to manage it, it is well worth while.

Those who start a salt-water aquarium and live near the sea coast will have immense pleasure in store. Many little pink and brown eggs, single and in groups, will be found in the sand or attached to rocks and seaweeds, which hatch out horseshoe crabs, periwinkles and other surprises. Eggs, plants and other living curiosities are washed up on the beach and the sea's wonders are endless.

851. What type and size of aquarium are suitable for salt water?

All glass aquaria are best, though rectangular tanks have been used successfully when the joints were well painted with black asphaltum varnish.

All glass seven gallon aquaria have been very successful, also from seven to 15 gallon metal frame. As with the fresh-water aquarium, the largest one can afford and accommodate always is best, but selection in this case should be guided by the amount of pure sea water one is going to be able to obtain from time to time, or if artificial sea water is attempted, by how large a collection of fauna one will be able to secure for it.

The salt-water aquarium should be covered with glass set on corks one-quarter inch above the top. This prevents the escape of crabs and snails, keeps out dust, and retards evaporation.

852. Will a salt-water metal frame aquarium require fresh cementing every year?

No. If the cement is properly mixed and good material used, it will withstand the action of salt water for a longer time.

If one wishes to make his own salt-water aquarium, the following cement, used by Mr. Lanier, will be found durable for more than two years:

- 11 parts whiting .
- 2 " red lead
- 1 part litharge

Mix thoroughly, then add boiled linseed oil, making this of a doughlike consistency, not too soft. Then add two tablespoons of lithographic varnish.

The color will be red. If brown is preferred, add one-half cup of black asphaltum varnish before the mixture is made too soft, or a very little lamp black will turn it dark brown. If too soft, add more whiting a little at a time. Mix well and work over with great care before using. This cement is suitable for both fresh- and salt-water aquaria.

853. What implements are necessary for the salt-water aquarium?

About the same as those needed for fresh water: siphon, cleaning razor, and forceps for the removal of dead plants and animals. A long wooden forceps is desirable and easily made by screwing two pointed sticks to a small rectangular base, one on each side of the base. This forceps can also be used to feed raw clam, mussel or fish to such stationary animals as corals and anemones, sponges, barnacles and sea squirts.

854. Will fresh-water plants do well in brackish or salt water?

No. In water containing 1% of salt, fresh-water plants gradually wilt and die.

855. How is the salt-water aquarium set up?

The salt-water aquarium, whether balanced or circulated, is better if started with pure sea water brought from a distance of 25 to 50 miles from the coast of large cities, or from the nearest sea beach which is not contaminated with sewage, to insure purity, proper salinity and the correct specific gravity. About two and one-half inches of gravel or clean sand may be used, and marine plants such as Sea Lettuce, Flame Weed and Sea Grass. Sea Fans and other Gorgonians (colonial animals related to corals), also small shore rocks, add a pleasing, natural effect. See artificial sea-water formula, No. 856.

The circulated aquarium must be provided with an efficient filter.

856. Can one prepare artificial sea water?

Yes. Synthetic sea water is used successfully for invertebrates at the University of Illinois, and has been used for many years for fishes

and other marine forms in the public aquarium in Berlin. First, one may like to know the specific gravity and composition of pure sea water.

The specific gravity at Nassau in the Bahamas is 1.027. It becomes less as one journeys north.

Chemical analyses vary with date, and in preparing synthetic sea water, aquarists formerly used only four ingredients—common salt, Epsom salt, chloride of potassium and chloride of magnesium; and they had no success whatever.

Now, however, we have a new analysis of sea water, given in *The Science of the Sea* (Bibliography No. 19), as follows.

The true composition of average sea water of a salinity of 35.00 per thousand, is:

Substance	Symbol	Parts per thousand
Sodium	Na	10.72
Magnesium	Mg	1.32
Calcium	Ca	0.42
Potassium	K	0.38
Chlorine	Cl	19.32
Sulphate ion	SO ₄	2.70
Carbonic "	CO ₃	0.07
Bromine	Br	0.07
Total		35.00

This book gives a formula for artificial sea water, the ingredients to be dissolved in pure water containing carbon dioxide. This formula is used at the University of Illinois (where it is known as Ditmar's formula). In aluminum frame aquaria of about five gallons' capacity, small invertebrates are maintained there for class study, the animals being shipped from biological stations on Atlantic and Pacific coasts, which supply only invertebrates. Glass covers limit evaporation, *Ulva* (Sea Lettuce) assists in oxygenating, and two or three inches of sand laid on the bottom keep burrowing animals happy. Rain water is used to replace water lost by evaporation.

The best success is obtained by supplying artificial aeration and keeping the aquaria at just above 32° for the first few days.

Sponges, anemones, corals, tube worms, snails, clams, starfishes, barnacles, crabs and other small crustaceans are maintained in this solution, and some have survived for more than 18 months. Marine jellyfishes have come into being here, 1,000 miles from the ocean. (Bibliography No. 218.)

Formula for Artificial Sea Water

(Used successfully in the University of Illinois for invertebrates only)

<i>Substance</i>	<i>Symbol</i>	<i>Grams per liter</i>
Sodium Chloride	NaCl	27.2
Magnesium Chloride	MgCl ₂	3.8
“ Sulphate	MgSO ₄	1.6
Calcium “	CaSO ₄	1.3
Potassium “	K ₂ SO ₄	0.9
Calcium carbonate	CaCO ₃	0.1
Magnesium bromide	MgBr ₂	0.1

Through the courtesy of Dr. D. O. Heinroth, Director of the Berlin Aquarium, the only public aquarium where artificial sea water has been used successfully, we are able to publish his formula there for:

Formula for Artificial Sea Water

(Used successfully in Berlin for all sea creatures)

In 100 cbm * of fresh water

2 816 kg	NaCl	Natrium chloride (kitchen salt)
65 “	KCl	Potassium chloride [A colorless crystalline salt occurring naturally in large deposits in Germany]
550 “	MgCl ₂ + 6H ₂ O	Magnesium chloride <i>crystallized</i>
692 “	MgSO ₄ + 7H ₂ O	Magnesium sulphate <i>crystallized</i>
25 “	NaHCO ₃	Natrium bicarbonate
122 “	CaCl ₂	Calcium chloride <i>dried</i>
100 g	KJ	Iodide potassium <i>crystallized</i>
100 g	NaBr	Natrium bromide <i>crystallized</i>

Figures refer to chemically pure salts.

To quote from Dr. Heinroth's letter:

“In our show tanks we have about 50 tons of [artificial] sea water and about 300 tons in our reserve tank and filters. The water

* Cubic meters.

is filtered day and night in long circulations through large sand filters. Moreover the water of each tank is also filtered with hydro-affin-carbon where airing is used. The renovation of the water follows always according to the case from about one year to two years. Its approximate density is 1.024."

BALANCED SALT-WATER AQUARIUM

ATLANTIC COAST

857. When did the balanced salt-water aquarium come into existence?

According to Gosse, marine aquaria first were accomplished by a Dr. Johnston in England in 1842, and were introduced into London in 1846 by a Mrs. Thynne.

858. When did balanced marine aquaria become fashionable in the United States?

About 1858. At that time Butler named 52 kinds of seaweeds suitable for a salt-water aquarium, besides invertebrates and fishes, and told how to collect one's specimens at ebb tide along the north Atlantic Coast. (Bibliography No. 3.)

859. How can inland dwellers get salt water with plants and animals for maintaining a balanced aquarium?

At the present time dealers do not make shipments inland of salt water with plants and animals therefor, although this formerly was done and probably will be done again.

It is safe to ship live material inland from December to February inclusive. Invertebrates, but not fishes or sea water, may be purchased from the supply department of the Marine Biological Laboratory, Woods Hole, Massachusetts.

860. How long will a balanced salt-water aquarium hold its integrity?

Balanced salt-water aquaria have been maintained in public schools in New York City from September to June without the loss of a fish and with only an occasional addition of tap water to replace that lost by evaporation. (The salt remains in the water, except for that taken up by plants and animals.) An occasional pinch of bicarbonate of soda will offset the acids given off by the animals.

861. How can a salt-water aquarium be balanced?

The aquarium with large surface area is most easily balanced. The addition of Sea Lettuce (*Ulva latissima*) creates a natural effect, large young bright green plants being best. The *Ulva* is floated on corks at one end, the other end being allowed to hang at the rear of the aquarium (nearest the light). The red alga (*Soleria chordalis*), also the Flame Weed (*Grinella americana*) add color. Sea Grass, which is brackish water *Potamogeton* (*P. pectinatus*), thrives in fresh,



Salt-water Balanced Aquarium, North Atlantic Coast

Showing Seaweeds and Brown Sea Anemones

brackish and salt water, is found from Canada to Florida and Texas, also on the California coast, and adds beauty and interest to the salt-water aquarium. This *Potamogeton* is found also in European waters.

There are over 100 species of ornamental red seaweeds.

A modern aerator helps somewhat in supplying the needed oxygen.

The balanced salt-water aquarium does better in strong light, with no direct sun. A northeast exposure has proved very successful.

862. How can the water be kept clear in a balanced salt-water aquarium?

By siphoning off the bottom until four-fifths of the water has been drawn and filtering this back, preferably through a funnel containing several thicknesses of cheesecloth or a loose wad of absorbent cotton. On gray days, a dipper full can be removed and allowed to fall back from a height of several inches—a very simple method of introducing fresh oxygen. Tap water may be added to replace that lost by evaporation. The salt is not lost.

863. How many animals to the gallon of water should one introduce in a salt-water balanced aquarium?

Three or four to the gallon until one becomes expert enough to manage more. (This refers to the invertebrates listed in No. 864.) The number of fishes depends on their size, the rule of one-half inch of fish to the gallon of water being a good one, where no aeration is used. When an aerator is used which gives off a very fine spray, it is possible to maintain 15 fishes about two inches in length in a 30 gallon tank. When circulating water is provided, flowing at the rate of two gallons a minute, one may maintain 75 fishes, from two to four inches long, in a 50 gallon tank.

864. What animals besides fishes may be introduced into a salt-water balanced aquarium in the latitude of New York?

Very small crabs (mud, spider and hermit crabs), prawns and shrimps, sea worms (annelids), anemones (brown and white), Northern White Coral (*Astrangia danae*), sea squirts (tunicates), naked mollusks, also little periwinkles, acorn barnacles, Rock Snails and



Oyster Drills can bore into the shells of other mollusks and suck out the tender flesh within. They should not be introduced into an aquarium containing any other mollusks large or small.

Mud Snails. Little-neck Clams, oysters and mussels are valuable as clarifiers, though not always long-lived. Stones are necessary for the attachment of anemones and hiding places for crabs, and empty shells of suitable size should be provided for house-hunting hermits.

Among animals to be avoided are Oyster Drills, which can bore into the shells of clams, oysters and other mollusks, and the hole bored is as perfect as though drilled by machinery. They then suck out the tender flesh within. They should not be introduced into an aquarium containing any other mollusks, large or small. Rock Snails eat barnacles. Young starfishes live only a short time and are destructive

of mollusks, applying their arms, which are well equipped with suction discs, to either side of the shell and pulling until the exhausted mollusk gapes, when they insert their eversible stomachs and enjoy a feast of fresh shellfish. A starfish can make away with 56 clams in six days.

865. What food is suitable for animals in salt-water aquaria?

Macerated clam, mussel or other shellfish, raw meat and fish, all are suitable. Drop the food in minute pieces from the end of a stick or wooden forceps upon the tentacles of corals and anemones. Remember that stationary animals are dependent on food floating to them through the water. All food not consumed within 30 minutes should be siphoned off.

For the inland aquarium, dried shrimp, desiccated Codfish after the salt has been soaked out of it, river mussels and fresh-water fish may be used if not oily.

Food should be given three times a week, sparingly.

866. Which crabs are most desirable for the Atlantic coast aquarium?

Only those of very small size are suitable, say one-half inch or smaller. They are most interesting animals, but except for the Horse-shoe Crab, they tear the Sea Lettuce to pieces and prey on other ani-



Empty shells must be provided for hermit crabs, which live in borrowed shells and go house hunting for larger and larger shells as they grow.

imals as soon as they are large enough to assert themselves. The decorator crabs, which heap seaweeds, anemones, tube worms and other animals on their backs for a roof garden under which they may travel unsuspected by their enemies, are as interesting as any, unless it be the fiddler crabs of various species, and the hermit crabs which live in borrowed shells.

The soft abdomen of the Hermit Crab (*Pagurus* and others) needs

protection from many enemies which find it a toothsome morsel, and it has developed the habit of concealing its rear end in any empty shell which fits, changing to larger and larger shells as it grows. The sixth pair of appendages takes the form of pincers, which enable it to hold tight to the borrowed shell. It prefers a shell covered with sea growths such as anemones and *Hydractinia*, which make it look like an animated marine garden. The house hunting of the hermits often is fraught with excitement, as when two fancy the same shell, or when the desired shell still is occupied by its original inhabitant, who is killed and dragged out piecemeal.

In the fiddler crabs the claws of the female are the same, but the male has one large claw and one small one.

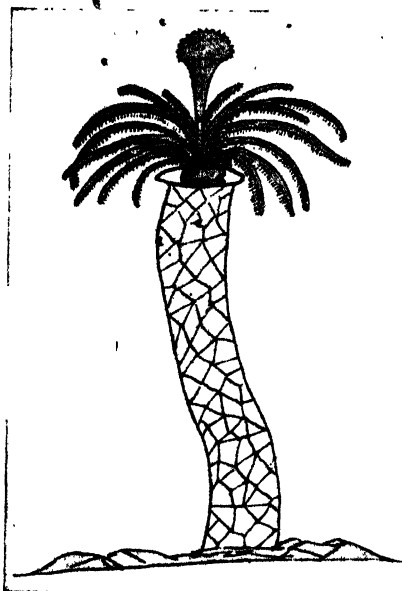
867. Of what interest are prawns and shrimps?

Prawns and shrimps, when about an inch long, make desirable adjuncts to the balanced salt-water aquarium. They like to burrow in the sand, with only the eyes and feelers exposed, but soon appear when food is introduced into the tank, and are very active in the water. The Common Prawn (*Palæmonetes vulgaris*) is distinguished from the Common Shrimp (*Crangon vulgaris*) by a sharply pointed, serrated spine which projects forward between the eyes. These are not brightly colored, but the Coral Shrimp (*Stenopus*), which ranges from New York to Brazil, has three scarlet bands across its white body and four across each of the clawed arms, and the sexes in this species swim side by side.

868. Of what interest are annelids or marine worms?

These creatures are among the most beautiful of small animals for the balanced salt-water aquarium, some being beautifully colored. Some swim freely through the water, others live in tubes. Among them are the serpulids, cousins of the earthworm and *Tubifex*, found on both coasts of the United States. These worms secrete for their habitation a limestone shell, tube shaped and sometimes coiled and contorted, into which they can retreat at will, many species being able to close the mouth of the tube with an operculum which often is armed with calcareous spines and plates. The gills of most serpulids are brilliantly colored, sometimes canary yellow or orange, sometimes purplish brown, banded with white and yellow, and have been likened to little passion flowers in a slender vase as they project from the tube.

The Sea Mouse (*Aphrodita hastata*) is a brown worm, oval in shape and about three inches long. Its sides are covered with irides-



A marine annelid (*Serpula*), beautiful cousin of the earthworm, living in a limestone shell secreted by itself.

cent, hairlike bristles. This worm is found on the North Atlantic Coast as far south as Long Island, and on the coasts of northern Europe.

869. Which are the most desirable sea anemones for the balanced aquarium on the Atlantic Coast?

There are several species of beautiful North Atlantic anemones, or "flowers of the sea," including the Brown Sea Anemone (*Metridium dianthus*), which extends from New Jersey to Labrador, sometimes is colored green or salmon, and is about three inches wide and four inches high; also the White-armed Anemone (*Sagartia lucolena*), a hardy species and a never-ending delight, reminding one of a swaying willow as it waves its graceful tentacles about in search of food. The body is about two inches high, the tentacles one inch long. The Crimson Anemone (*Tealia crassicornis*) is another handsome species, found north of Cape Cod, about two inches high and one and one-half inches in diameter. The Yellow-striped Anemone (*Sagartia luciae*) also is common on the North Atlantic Coast.

Though anemones are related to the fresh-water *Hydra*, they will not engulf other animals in the aquarium if well fed. Their natural food consists of crabs, fishes, snails, sea worms and even mollusks, one two inches in diameter having been observed to devour a scallop the size of a saucer. In captivity they will accept any kind of shellfish or fish, and also like raw beef.

Anemones are long-lived, one having lived in an aquarium in England for more than 66 years.

870. Of what interest are sea squirts?

The Sea Squirt, when touched, ejects with considerable force two fine jets of water through the two apertures at the upper end. Though it looks so simple, it is a highly organized animal. *Molgula*



The Sea Squirt (*Molgula manhattensis*), when touched, ejects with considerable force two fine jets of water through the apertures at the upper end. It has been likened to an Oriental water bottle with two spouts.

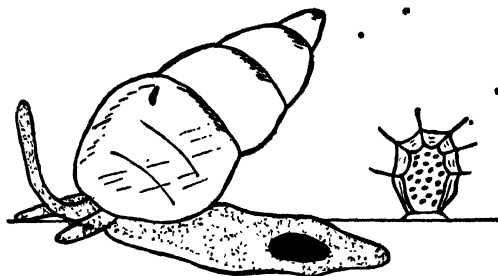
manhattensis, the species commonly taken in the latitude of New York, is greenish or grayish white and about one inch long. Sea squirts possess a strange anatomy, for having begun life as vertebrates, they degenerate, lose their eyes and other complicated structures, and settle down as a mass of tough, jellylike substance with a gelatinous rod as a backbone. They have been likened to Oriental water bottles with two spouts. These spouts are siphons. As with clams and mussels, currents of water enter one siphon (called incurrent) and leave through the other (called excurrent) after the animal has extracted from them the particles of food matter they contained. A Sea Squirt larger than *Molgula*, found on both sides of the Atlantic and in the Mediterranean, is urn-shaped, yellowish or green in color, and is known as *Ciona intestinalis*.

Sea squirts may be collected on Sea Lettuce (along with numerous other interesting animals which spend their lives floating about on this marine plant), and are common just below low water mark at-

- tached to rocks or masses of mussels, also on wharves. (Bionography No. 197.)

871. Which snails are best for the salt-water aquarium?

Large snails mow down the seaweed. The most satisfactory snail for the salt-water aquarium is the Mud Snail, the common little black snail which darkens the mud flats everywhere. It does little or no damage to plant life and only the Eel can surpass it in scavenging ability. It measures about one inch in length.



Drawn by Ida M. Mellen

Mud Snail with Urn-shaped Egg Case (Greatly Enlarged)

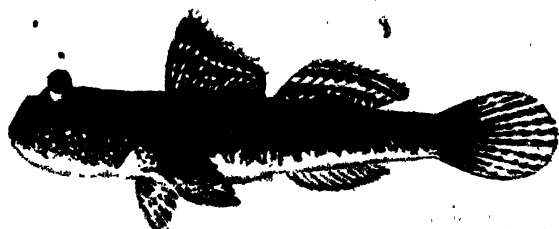
No salt-water aquarium is complete without the Mud Snail (*Nassa obsoleta*), which is found on nearly every coast, breeds at all seasons in the aquarium, and is an excellent scavenger.

The Mud Snail (*Nassa obsoleta*) attaches its urn-shaped egg capsules to the sides of the aquarium and to Sea Lettuce at all seasons, and the young hatch as free-swimming veligers. In two weeks they have grown their shells and no longer swim, but crawl on the large foot, like their parents. Sometimes Mud Snails acquire a covering of green algæ, and occasional specimens are so densely overgrown with the iringelike plant, *Enteromorpha*, as to resemble Sea Mice. No aquarium is complete without them.

872. Which species of fishes are available for a balanced salt-water aquarium on the Atlantic Coast and inland?

For the beginner, small brackish water species are best—Minnows, American Sole, Sticklebacks and Killies. (See Small Brackish Water Species of the North Atlantic, Nos. 901–927.) With a little experience, one may venture to keep Pomacentrids of southern seas, as the Gregorys, Starry-backs, Sergeant Major and many other kinds when under two inches in length.

Some Asiatic species, as the Walking Gobies (family Periophthalmidae), also are suitable for the balanced salt-water aquarium anywhere in America. The Mud Skipper (*Periophthalmus koelreuteri*), called also Mud Springer and Jumping Fish, is known to Africans as the Bommi. It has a wide distribution, being found in the Atlantic off the west African shore, in the Red Sea, the Indian Ocean about the Seychelles, Ceylon and northwestern Australia, also northeastern Australia on the coast of Queensland, in the North Pacific about China and Japan, and as far east as Polynesia. The generic name refers to the singular motility of the eyes, which can be moved independently and also projected from their sockets and retracted at



From a painting by Toshio Asaeda. Courtesy
California Academy of Sciences, Steinhart Aquarium

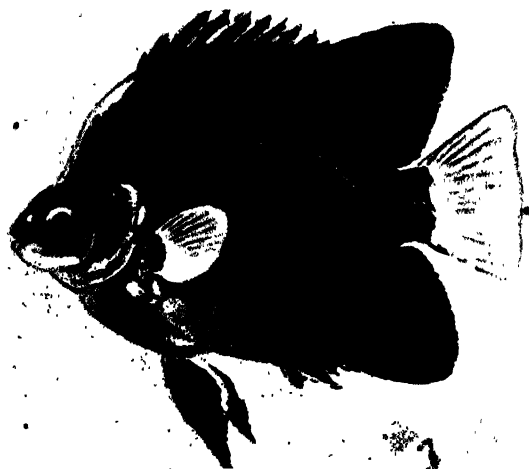
A Walking Fish

The Mud Skipper can project its eyes from their sockets and retract them at will. It likes to roost in the low branches of trees, and spends hours at a time out of water, with only its tail submerged. Rocks should be provided for it to roost on.

will, *Periophthalmus* meaning "an eye that turns around." The Mud Skipper must be kept in very shallow water, with suitable rocks for it to perch on, and will thrive without sea water, though a liberal mixture of sea salt or unadulterated table salt is desirable. It is called Mud Skipper because it skips about on land, darting over the mangrove and other mud flats after its prey (insects, worms, snails and the like), its pectoral fins being bent at an angle so that they support the weight of the body. These fins foreshadow the arm, elbow and hand of the amphibian. Several hours at a time are spent out of water, roosting in the low branches of trees, or longer stretches with only the tail immersed, and as this fin is highly vascular, it is believed to act as a respiratory organ. Meat, fish, shellfish, meal worms, wax-worms and similar live foods are relished, though the Mud Skipper will take hard-boiled egg yolk and other Goldfish foods. The

maximum length is six inches. The Mud Skipper does best when kept each by itself. This fish has a dark olive green back, lighter sides and light blue or gray belly. A thin black line runs from just above the pectoral fins to the base of the caudal, and above this line run irregular black bands from head to tail. The pectorals are fish green, spotted with blue and brown, the caudal is light brown with dark brown spots, the anal is pearly white at the base with a yellowish edge, and the dorsals are marked with three lateral bands, the lower one brown spotted with white, the upper one white spotted with red anteriorly, and the middle band black. In the second dorsal, the black band is bordered above with a red stripe edged with white.

The Scats of several species also may be maintained anywhere, and though kept sometimes in fresh water, are brackish water fishes. The commonest, *Scatophagus argus* (the name means "the scavenger with a hundred eyes"), makes such a delightful pet that a dealer who had agreed to trade one for other fishes found himself unable to make the exchange and paid outright for the other fishes rather than part



From a painting by Toshio Asaeda. Courtesy
California Academy of Sciences, Steinhart Aquarium

The Scat

A brackish water species, known in its native Oriental haunts as a scavenger, the Scat (*Scatophagus argus*) makes a delightful pet and sometimes is kept in fresh water.

with his Scat. The rectangular body is orange, yellow or greenish yellow, with many large black spots which sometimes disappear with age and the color becomes sea green. In its native haunts, the brackish waters of India, Ceylon, Malacca, Australia, China and the Philippines, it is known as a scavenger with an appetite for any sort of animal or vegetable foods. Fresh-water plants and lettuce are greatly relished in conjunction with meats, fish and other fish foods. The Scats belong in the family Scatophagidæ. In Australia they are called Butterfishes, and are used as food.

Another brackish water species of similar range, the Silver Finger, *Monodactylus argenteus* (family Monodactylidæ), with body shaped somewhat like that of the *scalare*, also can be kept in fresh water, or water with a touch of salt.

In captivity, both the Scat and the Silver Finger will grow to the length of one's hand. They are quarrelsome and do best in pairs, each kind by itself.

For these tropical species, a temperature of from 72° to 74° is desirable.

873. What is a Goby?

A Goby is a fish belonging to the family Gobiidæ, generally characterized by the absence of a lateral line and by having two dorsal fins, the first short and usually provided with six or more flexible spines. The ventral fins are united to form a sucking disc.

The United States boasts of nearly 100 species of Gobies, mostly marine, including the Blind Goby of the southern coast of California and the Sponge Goby, taken off the shore banks of North Carolina and Florida, where it lives in the cavities of sponges. Most of the Gobies which have been kept in aquaria have been salt-water species.

PACIFIC COAST

874. What animals other than fishes can be kept in a balanced salt-water aquarium on the Pacific Coast?

Anemones, crabs, shrimps, goose and acorn barnacles, tube worms and starfishes are chiefly to be desired for the balanced aquarium.

Anemones are found on all rocky shores, on pilings and in tide-pools. One of the loveliest of these is the Pacific Green Sea Anemone (*Byadactis xanthogrammica*), with a variously colored body—greenish white to green, brown or pink. This anemone is found between tidewater marks, from San Francisco to San Diego.

Among the Pacific Shore crabs are several interesting species. The Purple Shore Crab (*Hemigrapsus nudus*) and Yellow Shore Crab (*H. oregonensis*) both make good scavengers, and commonly are found together. The Purple Shore Crab varies greatly in color, being greenish yellow, reddish brown or purple. It has smooth legs and red spots on its claws, which distinguish it from the Yellow Shore Crab (called also the Mud Crab and Hairy Shore Crab), which is buff colored and has hairy legs and no red spots. The Yellow Shore Crab is an exceedingly common species on mud flats from Mexico to Alaska.



Photograph by J. Solini

A circulated salt-water aquarium on the Pacific Coast (Steinhart Aquarium) showing Anemone Fishes and Pacific Green Sea Anemone, also Sea Fan and other Gorgonians.

Like the Atlantic, the Pacific has its hermit crabs which must be provided with larger, empty shells, for new homes as they grow and seek more comfortable quarters.

Many species of shrimps serve both as food for fishes and as scavengers. Perhaps the most interesting is the Snapping Shrimp (*Crangon dentipes*), which has a habit of making a snapping noise with the finger of its big claw as it strikes the glass against the second joint in closing. When it snaps in the aquarium, it sounds as though the glass had cracked. When it snaps in one's hand, it is distinctly felt, and sometimes may pinch. The body of this shrimp is greenish to greenish blue, the last segment of the abdomen is orange, and the antennæ are yellowish brown.

Goose Barnacles (*Mitella polymerus*) and Acorn Barnacles (*Ba-*

lanus tintinnabulum) are found along the coast, the former being stalked, the latter sessile, acornlike, and sometimes very large. The feathery feet of the barnacle are thrust out as the tide rises, sweeping food into the mouth.

The tube worms of the Pacific are interesting and beautiful. One of these (*Serpula columbiana*) lives under stones or in tide-pools near low water marks. The coiled, calcareous tube which it secretes for its dwelling is cream-colored, and the gills are red and cream. Another interesting sea worm is the Feather Duster (*Eudistylia polymorpha*), which lives in a translucent tube and may be found on rocks or pilings, often covered with bits of sand and shell. It extends from San Pedro to Alaska. The feathery gills may be purple, red or yellow, or banded with two colors. It is strikingly handsome, and, like other tube worms, disappears quickly into its shell when disturbed.

The Ochre Starfish (*Pisaster ochraceus*) is desirable only when very small. It can be collected on rocks at low tide and in shallow water, from San Diego to Alaska. (Bibliography No. 54.)

875. What plant life can one use on the Pacific Coast for balanced salt-water aquaria?

The Pacific Sea Lettuce, *Ulva angusta*, which resembles Atlantic Eel Grass excepting that the leaf is corrugated, adheres to rocks in tide-pools and is taken, anchorage and all, for planting in the aquarium. Another species, sometimes found floating in large sheets, is *Ulva expansa*. This can be suspended from the surface with small bits of cork, allowing it to hang down about half way into the tank, which gives a very pleasing effect.

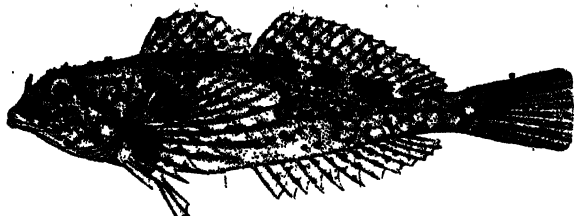
876. Which fishes are appropriate for a balanced aquarium on the Pacific Coast?

Most small individuals of the species recommended for a circulated aquarium can be maintained in a balanced aquarium if there is plenty of oxygen, the Anemone and Clown Fishes, which are only about three inches in length at maximum, the Kelpfishes, and the rest.

Many shore and tide-pool species are desirable for this purpose, including Killies (Cyprinodontidæ), Scaleless Sculpins (Cottidæ), Scaled Sculpins (Icelidæ), Pomacentridæ, Wrasse fishes (Coridæ), Blennies and others.

KILLIBS AND SCULPINS

The Small-fin Killifish (*Fundulus parvipinnis*) is common from Point Concepcion to Cerros Island, favoring bays and lagoons, especially about San Diego, and is a hardy and interesting species for the home aquarium. It reaches a maximum length of four inches. Females, which are larger than males, have fish green sides and an indistinct lateral stripe on the caudal peduncle. Males are light olive green, mottled with indistinct dark green, and have a brassy glint on the sides, which are crossed with 20 short, dark bars.



From *The Tide-Pool Fishes of California*, by Arthur White Greeley, U. S. Fish Commission Bulletin, 1899

Greeley's Red Sculpin (*Greeleya rubellio*)

This is regarded as the most brilliantly colored of California tide-pool fishes. The body displays every tint and shade of red, with touches of lavender, and is spotted all over with white. The brown head is blotched with ruby or emerald, the throat and belly are light robin's egg blue.

Among the tide-pool Scaleless Sculpins are the Monterey Blenny, Greeley's Red Sculpin, Rock-pool Johnny and Woolly Sculpin. The first (*Montereya recalva*) is found from Monterey Bay to San Diego in the smaller tide-pools and shows a variety of colors from pure green (if found among green algæ) to brown and white with a pink tail. This species reaches a maximum length of three and three-quarter inches and is very attractive for the home aquarium.

Greeley's Red Sculpin (*Greeleya rubellio*), is regarded as the most brilliantly colored of California tide-pool fishes and inhabits only the deeper pools. The body displays every tint and shade of red, with touches of lavender, and is spotted all over with white. The brown head is blotched with ruby or emerald, the throat and belly are light robin's egg blue. All the fins save the ventrals are brownish-green barred with rock brown and the tips of the anal and pectorals are pink.

The Rock-pool Johnny (*Oligocottus maculosus*) is not only one of the smallest of Pacific Coast species but one of the most colorful. It seldom exceeds three inches in length and is common from Cape Mendocino to Point Concepcion. The little fish is able to match its surroundings, and the body color varies accordingly from reddish brown to gray, vivid green or crimson. All the fins are barred, the belly usually is livid bluish or greenish, and the lower side of the head is mottled with white. The Rock-pool Johnny does well in the home aquarium, surviving for upwards of two years.

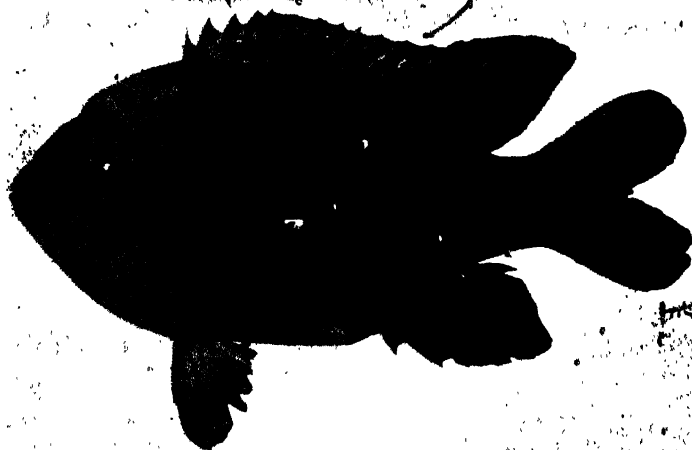
The Woolly Sculpin (*Glinocottus analis*) is common in tide-pools from Point Concepcion northward on the California coast. The color varies from olive green to dark brown, and some specimens have numerous white and black spots and are mottled with red. The fins are all spotted, and the presence of numerous, whitish cirri give the fish a woolly appearance. The length is from three to seven inches.

Among the Scaled Sculpins, one of the most attractively colored is Artedi's Lined Sculpin (*Artedius lateralis*), ranging from Puget Sound to Point Harford. A handsome but idle fish, it lies close to the rocks and never is known to hurry or to gather for a social season with its congeners. It is found everywhere in tidal pools, deep and shallow, usually singly. The colors are brown and green, reticulated with white, and several lavender bands cross the body. The lower jaw is lemon, the throat brown.

POMACENTRIDS

One Pomacentrid to be recommended is the Sergeant Major which is common in rock pools about Mazatlan and is almost precisely the same as its Key West brothers. Some specimens are bright greenish yellow above with steel blue bands. The dorsal fin is colored like the back, the other fins are dusky. Only one, or one pair, can be kept in small quarters because of the quarrelsome nature.

Like the Atlantic, the Pacific has its "marine Goldfishes," the Garibaldi or Sea Goldfish (*Hypsypops rubicundus*) having proved a very handsome and hardy species for the aquarium, especially when small. The scarlet sides have numerous marks and spots of an intensely bright blue color, which sometimes changes to bluish green. The anal fin is red, the dorsal dotted with blue, pectorals and caudal are semi-translucent, plain reddish, and the first rays of the ventral and tips of anterior rays of the anal are blue. This beautiful Pomacentrid is taken commonly around Santa Catalina Island, but extends south to Point Concepcion. It favors rocky locations where kelp abounds.



Courtesy California State Fisheries Laboratory

The Garibaldi or Sea Goldfish of the Pacific is a handsome and hardy species, suitable, when young, for the salt-water balanced aquarium.

WRASSE FISHES, KELPFISHES AND BLENNIES

The Señorita (*Oxyjulis californicus*) is one of the Wrasse fishes, ranging from Monterey to Guadalupe, and being especially common about the kelp and the rocks at Monterey. The maximum length is seven inches, and only young specimens are desirable for the home aquarium. The body is fish green, the centers of the scales being orange brown. The belly is creamy, sides of head alternately striped with blue and brown. A large blue black blotch lies at the base of the caudal fin.

The Spotted Kelpfish, called also Señorita (*Gibbonsia elegans*), of the family Clinidae, attains a length of eight inches, but small individuals may be taken in rock pools, also in kelp along the coast from Point Concepcion to Todos Santos. Rock pool specimens are more brightly colored, the body being red or brown, usually with eight irregular darker cross bars extending on the dorsal and anal fins, and with many spots, light and dark, on the head and fins. The pectoral and caudal as a rule are barred.

Very young specimens of the Long-nosed Kelpfish (*Heterostichus rostratus*), of the same family, may be taken in kelp along the coast from San Francisco to San Diego. The bodies of small individuals resemble the kelp in color and are reddish brown, varying

to olive or blackish, with a silvery stripe from the dorsal fin to the lower lip. There are translucent spots in the dorsal fin and a series of large, irregular light spots on the sides below the lateral line. Sixteen inch specimens have been recorded.

Pleasing among the Blennies (family Blenniidae) are Gilbert's Blenny and the Leaping Blenny, the former found in kelp and rock pools from Point Concepcion south to Todos Santos, and in the Santa Barbara Islands among rocks, the latter taken on both coasts of tropical America, north to the West Indies and to Todos Santos, Lower California. Gilbert's Blenny (*Hypsoblennius gilberti*) reaches a maximum length of five inches, is fish green in color, profusely mottled and reticulated with darker, obscure shades, which extend down from the eye across the lower side of the head. Faint streaks radiate from the eye. The Leaping Blenny (*Rupiscaetes atlanticus*) reaches a maximum length of from six to eight inches, is reddish brown, usually with five or six darker cross bars extending on the dorsal fin, and with a black spot behind the eye. On the upper part of the caudal there is an orange area, on the lower part a yellowish area with a reddish tinge.

The Kelp Blenny (*Phytichthys chirus*), of the family Xiphisteridae, is very common along the Pacific Coast from Monterey to Alaska. Its sides are greenish brown spotted with different shades, such as green, dark brown and yellow. Some specimens may be a uniform yellow, brown or green. The body is eel-like, the dorsal fin extending from the top of the head to the base of the caudal fin, while the anal fin extends from the center of the body to the base of the caudal. It reaches a length of six inches. Fish, shellfish and beef are taken in captivity, and the Kelp Blenny searches around the bottom of the tank after the manner of a fresh-water scavenger for any food that may have fallen.

GULF COAST

877. Which fishes can be kept in a balanced salt-water aquarium along the Gulf Coast?

Many Killies of the genera *Cyprinodon* and *Fundulus* will be found distributed along the Gulf Coast, such as the Sheepshead Minnow (*C. variegatus*), the Rainwater Fish (*Lucania parva*), the Common Killie of the Gulf Coast (*F. heteroclitus grandis*), and Mayfish (*F. similis*). *Zygonectes pulvereus* and *Z. jenkinsi*, found along the coast of Texas are attractive species, also *Adinia multifasciata*, which is abundant in shallow lagoons from the west coast of Florida to Texas. Better known is the Galveston Killie (*F. pallidus*), taken in the brack-

ish waters of Texas. This is a light colored Killie of silver blue and ivory, dotted with pale green. Mollies also are found in the brackish waters of Texas, and *Gambusia patruelis* is common in the marshes and lagoons of Texas.

The Mayfish (*F. similis*) is found in brackish waters and shallow bays, having been described from Texas as early as 1853. It is known also to enter the sea. It is one of the handsomest of brackish water Killies, the slender, graceful body being vertically barred with black in both sexes, the male having a black spot at the rear of his dorsal fin, with another, smaller spot behind the eye. The scales are large and the darker ones on the back are edged with silver. The belly also is silvery. The caudal fin is rounded. The Mayfish reaches a length of six inches, is a vigorous hunter of mosquitoes and therefore desirable for the southern brackish-water pool, as well as a pleasing species for the balanced salt-water aquarium along the Gulf Coast.

UNHEATED, CIRCULATED SALT-WATER AQUARIUM

878. How can one determine whether the specific gravity and salinity are correct?

By the use of a hydrometer and a pH testing outfit.

879. How can acidity in salt water be detected?

By the use of an aquarium tester for pH values, or the old-fashioned way, by testing with litmus paper.

880. Is a salt-water aquarium difficult to maintain?

A salt-water aquarium, if the care and feeding of the fishes is not vigilantly attended to, will go bad in three or four days. A fresh-water tank stands neglect and abuse much longer. An efficient filter is necessary for the circulated aquarium.

881. If a salt-water aquarium for the home is provided with a filter and continual circulation established, if the salinity and pH values watched, how long will it retain its integrity?

This experiment has not been made in the home, but in public aquariums, fishes are kept in this manner and the same sea water is used continually year after year. Water lost by evaporation is replaced with fresh tap water of nearly the same temperature. Only when the water is rendered foul by dead fishes or other animals, or by uneaten food, does it become necessary to change it completely; or, if disease



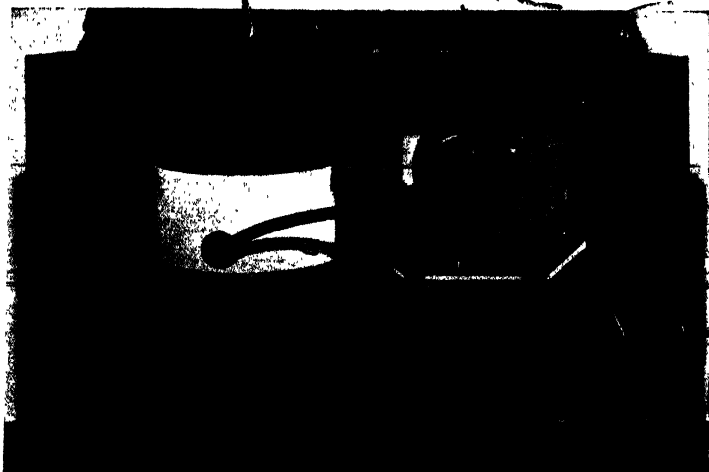
Photograph by S. C. Duntun

A salt-water aquarium for the parlor, designed by Hamilton C. Knowles. The unheated water is circulated through the tank by a non-metallic pump and pipe system and returns to a filter-reservoir in the cabinet beneath. The black fish with white stripes is a young French Angel, the little one in front of it a Sergeant Major. At the top of the tank at the right is a Parrotfish, beneath it a Squirrelfish, Blue Angel and Butterfly, all Florida species which have survived at living-room temperature in the latitude of New York.

present, a change is advisable. Occasional additions of salt water to be found beneficial.

When salt-water plants are used in the aquarium, they should be checked and removed as soon as they show signs of wilting.

If the water has become acid because of too slow circulation or too many fishes, it may be remedied by adding a small amount of bicarbonate of soda.



Photograph by S. C. Duntun

Detail of cabinet containing Knowles' closed circulating system for an unheated salt-water aquarium in the home. In the left compartment the large crock serves as a reservoir. A filtering agent is placed in the bottom of the crock. From there the water flows through a rubber pipe to the next compartment to a special centrifugal hard rubber pump of special design. This forces the water into the tank above. From there it is returned by gravity to the tank below.

NORTH ATLANTIC FISHES

882. Which North Atlantic fishes can be kept in an unheated circulated salt-water aquarium?

Small North Atlantic species include the Sea Horse (*Hippocampus hudsonius*) and its cousin, the Pipefish (*Syrichtes fuscus*), which are to be adopted only when a plentiful supply of live food is available, their feeding habits being similar. (See also Nos. 883, 884, 887.)

The Sand Lance or Launce (*Ammodytes americanus*), if it can be provided with sand for concealment, may be of interest. (See also Nos. 885, 886.)

Various salt-water Killies of the North Atlantic include the Common Killifish, Bass Killifish, Rainwater Fish and Sheepshair Minnow, which live also in brackish water and are described under Brackish Water Species, Nos. 901-927.

The Silver Moonfish (*Argyrosomus vomer*) is one of the most beautiful of North Atlantic species, recognized by the perpendicular

slant of the head and high forehead, also the remarkably compressed body, which shines in the water like a moon of mother of pearl. The young resemble Thread Fishes, with long, picturesque filaments trailing from both dorsal and anal fins. This fish is found from Cape Cod to Brazil and from Lower California to Peru, and is hardy in captivity, surviving for more than five years. It is called also the Lookdown and Horsehead.

The Pompanos, Common and Round (*Trachinotus carolinus* and *T. falcatus*), range respectively from Cape Cod to Texas and Cape Cod to Brazil. The young, two or three inches long, are carried north in the Gulf Stream and netted in New York waters in summer. Presenting an alluring picture of living, flashing silver, they seem never to pause for rest. They are hardy and have survived for four and one-half years in captivity. They are in the same family with the Silver Moon (*Carangidæ*) and have the same short chins, deeply forked tails, and long first rays of dorsal and anal fins, but their bodies are fuller and more fusiform.

The Pigmy Sculpin (*Acanthocottus æneus*), which is scaleless, is related to the Cottidæ of Pacific tide-pools, though not as colorful. (See also No. 888.)

The silvery little Harvestfish, Butterfish or Dollar-fish (*Poromotus triacanthus*) is very common from Nova Scotia to Florida, and specimens of the size and color of a silver dollar are very pleasing. This fish is in the family Stromateidæ or Fiatolas.

The Spot or Lafayette (*Leiostomus xanthurus*), extending from Cape Cod to Texas, is also desirable when of the size of a silver dollar. (See also No. 889.)

Very small Puffers (*Spheroides maculatus*) are greatly to be coveted. They are among the few fishes which can be taken from the water to amuse one's friends. (See also No. 890.)

Small Sea Robins of any species may be kept. These include the common Sea Robin (*Merulinus carolinus*), Striped Sea Robin or Gurnard (*Prionotus strigatus*), and Southern Sea Robin (*P. caeruleus*). Some two dozen species are known, all in the family Triglidæ and mostly of the tropical Atlantic and Pacific. (See also No. 891.)

Good specimens of the Naked Goby or Oystershake (*Gobiosoma boscii*) will last for one year in the aquarium. This species may be found coastwise from Cape Cod to Florida among the Eel Grass and weeds. It is wholly scaleless.

Stargazer (*Astroscopus guttatus*), found from Long Island Virginia among the shallows, likes to bury itself partly in the sand, and will be recognized by its flat head with the eyes at the top like those of the Celestial Goldfish, and its nearly vertical mouth. Others

of this family (Uranoscoipidae), are taken in the South Atlantic and Pacific.

The Slippery Dick or Sand Eel (*Rissola marginata*) ranges from New York southward to Pensacola, being available for those living on the North and South Atlantic Coast, as well as for dwellers on the west coast of Florida. It is unrelated to the Slippery Dick, *Iridio*, of Florida waters.

Any Flounders of small size may be kept, though they are not long-lived in captivity. Puffers, if large enough, will take round bites out of them. Sea Robins also prey on Flounders, and the Flatfishes may not be averse to retaliating. A baby Flounder will give a sharp nip to a finger unsuspectingly dangled in the tank. The common North Atlantic species of Flounders are the Summer Flounder or Fluke (*Paralichthys dentatus*), Four-spotted Flounder (*P. oblongus*), Winter Flounder (*Pseudopleuronectes americanus*), and Window-pane Flounder (*Lophopsetta maculata*). (See No. 892. Also, see American Sole or Aeroplane Fish, Nos. 924-926.)

The Spiny Boxfish or Burrfish (*Cyclichthys schæpfi*) might be called an aquatic dirigible from the stiffness of its movements, due to the inflexible body and short fins, and it is very tame and sturdy, feeding from the fingers, and surviving for three years or longer in the aquarium. Though properly a West Indian species, it is commonly taken in New York waters. Its body is covered with short spines, and it has a parrotlike, bony beak.

The Common Toadfish (*Opsanus tau*) is grotesque and somewhat sluggish, but no salt-water aquarium seems quite complete without it in the latitude of New York. It has survived for five years in captivity, and is the only member of its family (Batrachoididae) living in the North Atlantic, other Toadfishes being taken in the tropical Atlantic and Pacific. (See also No. 893.)

These are some of the possibilities among small species which have been found in the North Atlantic, but of course the sea is full of interesting fishes and the majority live amicably in an aquarium if taken when small.

883. What are the special requirements of the Sea Horse?

The Sea Horse eats nothing but live food in the aquarium as in a state of nature, dying rather than accepting anything inert. Its favorite food is the tube worm, *Serpula*, impossible to provide in captivity. Very few specimens will accept *Enchytraeus*, *Tubifex*, bloodworms or *Asellus*. The salt-water *Gammarus* forms an acceptable tidbit, as also the brine shrimp, *Artemia*; and the Sea Horse will take fresh-water gammarids, which can be raised for it. *Daphnia* are eaten if perceived

in time (they live 25 minutes in salt water) and the fry of toy tropicals are eagerly snapped up. A Sea Horse can eat 15 two-day-old Guppies at one meal.

A food which doubtless would prove acceptable, though not yet tried, is the larva of the salt marsh mosquito.

Provide the Sea Horse with something to cling to. Branched coral is excellent for this purpose, also twigs and branches firmly secured.

884. What are the interesting characteristics of the Sea Horse?

The Sea Horse, whose body is encased within a bony armor, swims in various positions, always head up and never backward but at an angle or horizontally. It is tame and will swim into the hand. It has a prehensile tail by which it clings to seaweeds and other objects. It makes a clicking sound distinctly heard outside the water, when snapping up its food. Its eyes move independently, i. e., one can look up while the other looks down. The male carries the eggs in a brood pouch where they are placed by the female, and he compresses the pouch to urge the young forth when they have hatched and are ready to leave. Many have hatched in captivity but there is as yet no record of their survival, the proper food—oceanic plankton—being hard to provide and difficult to match.

If the water and food are correct, adult Sea Horses will survive for three years in captivity.

They do best in a tank with their own kind. Other animals annoy the Sea Horses. Shrimps, for example, ride on their backs and worry them.

The North Atlantic Sea Horse is found from Cape Cod to the Tortugas.

885. What are the characteristics of the Sand Lance?

The Sand Lance buries in six inches of sand, and though abundant on sandy shores, it is delicate in captivity. The eggs hatch in mid-winter, and the young therefore are taken in March in Massachusetts waters. This little fish ranges from Newfoundland to Cape May and Cape Hatteras, and averages five inches in length, with a maximum of eight. In some localities it is called Sand Eel.

886. How can the Sand Lances be distinguished from young Eels?

The Sand Lance has no ventral fins and the long dorsal and shorter anal are not connected with the forked caudal fin, whereas

in the Eel the dorsal, caudal and ventral fins are confluent and the tail is rounded. The Eel is a uniform greenish brown or black, and the Sand Lance is green and silver with a steely blue stripe on the side. The eye is silver with a black pupil. These fishes are not related, the Sand Lance being in the family *Ammodytidae*.

887. What are the interesting features and the food requirements of the Pipefish?

The male Pipefish, like the male Sea Horse, carries the eggs in a ventral pouch. The Pipefish breeds in brackish water from March to August, though it lives normally in seaweeds along shore and sometimes strays into the open sea. Contrary to common belief, the Sea Horse is not the only fish with a prehensile tail, some Pipefishes of Bermudian, Australian and European waters also having prehensile tails. (Bibliography No. 196.)

Like that of the Sea Horse, the body of the Pipefish is encased in bony plates, and these fishes are cousins, in the same family, *Syngnathidae*, Sea Horses belonging in the subfamily *Hippocampinae*, Pipefishes in the subfamily *Syngnathinae*.

Pipefishes eat fish and shrimp eggs, fish fry, "water fleas" and sea worms, but will eat nothing that is dead. Some will spend hours snapping up black aphids, others would starve rather than touch an aphid.

The North Atlantic Pipefish ranges from Maine to Virginia and is very common northward. The name of Pipefish derives from the long, narrow body, slender as a pipe stem.

888. Of what interest is the Pigmy Sculpin?

It is the smallest American Sculpin, averaging when adult only five inches, and the eggs adhere to seaweeds and are a beautiful green. It is found only between southern New England and New York.

889. Of what interest is the Spot?

Its other name of Lafayette was given it when General Lafayette revisited America in 1824, this fish having been exceedingly abundant in New York waters at that time. It swims with the jellyfishes, which sometimes seize it. It is called Spot because of a "thumb mark" at the base of the pectoral fin. Actually it is one of the Croakers (family *Sciaenidae*). The sides are silvery, with many black wavy vertical lines.

890. Of what interest are Puffers?

Fishes of this family (Tetraodontidæ or Puffers) are interesting because of their habit of inflating in self protection, with air or water, at or under the surface, which prevents certain enemies from swallowing them. Thus puffed into a round, taut ball, they float on their backs and sometimes are carried by the wind to a safe distance from their pursuers. Puffers of different species are found in several seas.



Photograph by Elwin R. Sanborn

Puffers inflate with air when scratched on the rough under surface and are among the few fishes which can be taken from the water to amuse one's friends. The young, with the same inflating habit as the adults, are enticing.

North Atlantic Puffers may be taken anywhere between Cape Ann and Florida. The Common Puffer, when removed from the water and scratched on the under surface, fills itself with air. (This should not be done immediately after a meal, or it will lose its dinner.) It will breed in captivity under favorable conditions, and the young, with the same inflating habit as their parents, are most enticing. Puffers are destructive of other fishes, however, and must be kept by themselves. The maximum length is eight inches, nine including the tail. The entire body is covered with minute prickles, the color is

yellowish gray above, pale yellow beneath, with about five "thumb marks" between the pectoral fin and caudal peduncle. The mouth is fitted with a bony beak divided in the center to form two teeth in each jaw. These can be very serviceable on occasion, for it was a species of Puffer which Darwin described as having escaped from a shark that had swallowed it, by eating its way "not only through the coats of the stomach, but through the sides of the monster." The eyes are like a pair of gleaming opals.

891. Of what interest are Sea Robins?

The common Sea Robins are not only beautiful with their wing-like red or orange pectorals, but they "walk" on the bottom of the sea with the fingerlike projections of the pectoral fins. (Actually they are stirring the sand to rout their prey, which consists of small animals such as clams, Flounders, squids and sea worms.) If one is lucky enough to get the floating orange eggs, they may be hatched in flowing sea water. The North Atlantic Sea Robins extend from Cape Ann south to the Carolinas and Virginia.

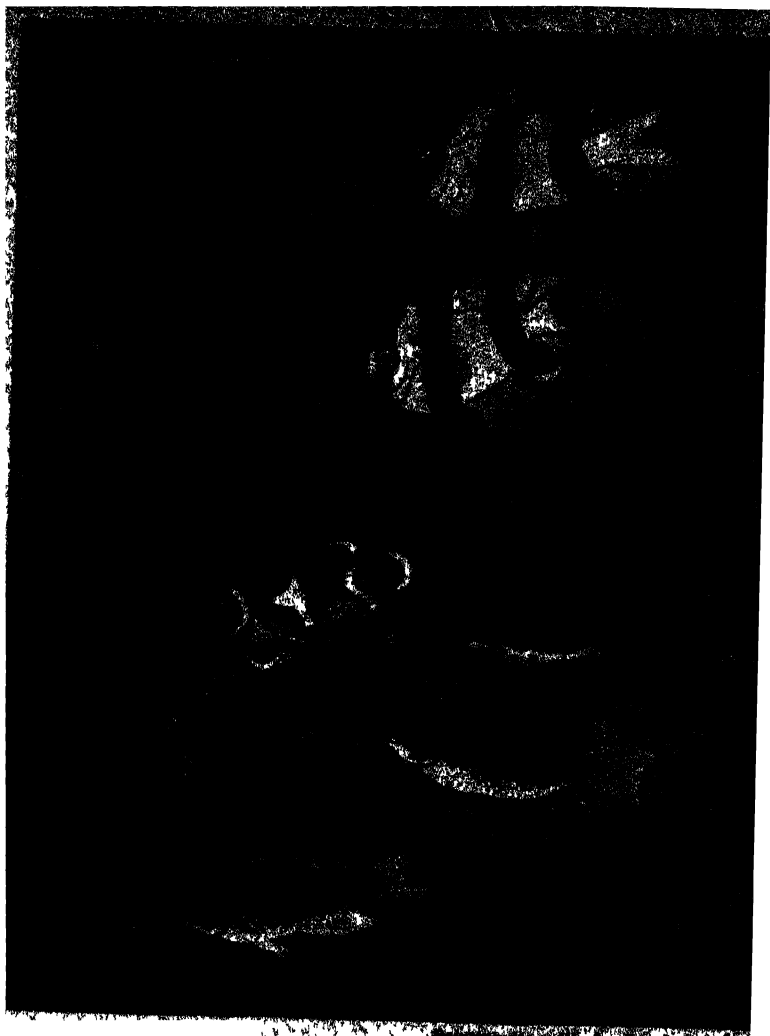
892. What is interesting about Flounders or Flatfishes?

The chief interest attaching to Flounders is the fact that they hatch like other fishes with an eye on each side of the head, but one eye travels around or even through the head, sometimes the right, in other species the left, and when both eyes are on the same side the Flounder sinks to the bottom and swims on one side, though it will rise to the surface to pursue its prey (little fishes, squids, shrimps and the like). The young of the Winter Flounder are common in New Jersey waters in summer.

Many Flounders assume a pattern so like the surface on which they rest that if a strip of figured oilcloth is slipped beneath them, they will match its design.

893. What is there of interest in the Toadfish?

The Toadfish loves to lie among rocks, and in the aquarium will seek crevices in which it rests in various positions, even upside down, supporting itself partly with the spine at the front of the ventral fin. In a state of nature, it is interesting because the male fish guards the eggs and fry, and the female has a unique habit of selecting for her cradle empty sea shells and strange objects from the human discard, such as old boots and saucepans. It is called an ugly fish, but there should be nothing repulsive about it to a "fish fan." The body is gray or dark brown, black along the back



THE DAMSELFLIES

The Damselflies are very active, brilliant little fishes of the coral reefs, often seen also in tide pools. Upper: Black and White Damselfish (*Stegastes leucostriatus*) and Black Damselfish (*A. melanurus*); Center: Red-tailed Damselfish (*A. melanurus*); Lower right: Damselfish seen from above; Lower left: Damselfish seen from below.

and with long black wavy horizontal stripes on the second dorsal, another stripe running vertically through the center of the stubby tail, and still another through the center of the large pectoral. There is a short first dorsal, the second dorsal and anal fins being long. The eyes are set at the top of the head, enabling the fish to look forward and upward. Little horns project above the eyes, and a fleshy pointed frill, extending from the lower edges of the gill covers forward, surrounds the lower jaw. The Toadfish can live for a long time out of water. In the aquarium, it will last for five years.

It is found from Massachusetts to the West Indies.

PACIFIC COAST FISHES

894. Which salt-water fishes of small size are most desirable in the circulated aquarium on the Pacific Coast?

Those taken in the waters of southern California, of the Dutch East Indies, Mexico, Hawaii, Fiji, Galapagos and Samoa. The most beautiful, active and interesting of these are the Pomacentrids or Demoiselles. Among them figure the popular Damselfishes.

POMACENTRIDS, INCLUDING DAMSELFISHES

The Banded Damselfish (*Abudefduf abdominalis*) lives in the waters of Hawaii, its cousin the Pintano (*A. troscheltii*) is taken about Mexico and the Galapagos, and the Sapphire Damselfish (*A. taupou*) comes from the Samoan Islands. The body of the Sapphire Damsel reaches a maximum length of two and one-half inches, the color is deep sapphire blue, with a golden belly, scarlet dorsal, bluish pectorals and caudal, and orange anal and ventral fins. *A. uniocellatus*, from Samoa and Fiji, is brilliant blue in color, spotted with golden yellow. *A. dicki* is taken in the waters of Samoa, the East Indies and Polynesia, and the body is golden brown, with a salmon tail and bright golden pectorals, set off by a black transverse bar running from the soft dorsal to the soft anal.

The Blue Damselfish (*Pomacentrus pavo*), with a maximum length of two and one-quarter inches, comes from East Africa, Melanesia, the East Indies and Polynesia, and is another richly colored pigmy, the color being bright blue with brighter blue spots on the back and head, and a black spot on the opercle. The fins, breast and belly are pale brownish, and the edge of the dorsal fin is dusky.

Some Anemone Fishes are the Red-banded Clown (*Amphiprion biocellatus*) from Java, *A. frenatus*, which is taken in the Red Sea, in waters about Zanzibar, Ceylon, India, the East Indies, China,

Japan and Melanesia, and which is colored orange and red, with one pearly band across the head, and the common little reef fish; called the Yellow-banded Anemone Fish (*A. percula*), believed to be largely responsible for the present revival of interest in the salt-water aquarium in the home, with its orange body marked with three cross bands of pearl edged with black, and its orange fins with a white edge and submarginal stripe of black. This coveted little fish, not quite two and one-half inches long, has a very wide range, being taken throughout the Indo-Pacific from India and China south to Australia, and in the waters of Melanesia and Polynesia. It propagates nearly the entire year, some other Damselfishes being restricted to a definite spawning period. The female is larger than her mate and is more active during courtship, but the male works continually to clear the eggs of sediment. In the aquarium, the eggs are fastened to coral rock near an anemone. One brood numbers from 200 to 300, and 11 broods may be produced in three and one-half months, making a total of about 5,000 eggs a year. The time between broods ranges from seven to 14 days. The fry hatch in seven days and are four mm. long, and when free swimming, they rise to the surface to feed on planktonic life for about 12 days, then seek the bottom to search for anemones. They may settle in an anemone with adult fishes, and after they reach a certain size the older ones drive them out. Some of the anemones in which these little fishes seek shelter may measure a foot in diameter.

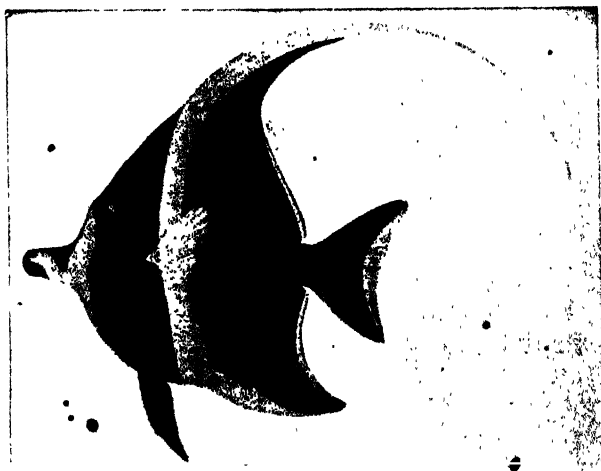
Dr. J. Verwey of Batavia, to whom we are indebted for our knowledge of the habits of the Anemone Fishes, discovered, in his *Coral Reef Studies of the Symbiosis between Damselfishes and Sea Anemones in Batavia Bay*, that the little fishes bring food to the anemones which provide them with shelter from their enemies (chiefly larger fishes), that the instinct for maintaining a certain territory is strongly developed in them, and that more than one pair of fishes may make their home in one anemone. Barrett and Whitley, in *Water Life*, say that a red, white and orange shrimp often shares an anemone with the fishes.

Other Pomacentrids are the Blacksmith (*Ayresia punctipinnis*), found on the coast of California from Point Concepcion to Cedros Island; the Two-colored Bluefishes, of which *Eupomacentrus rectifraenum* is common on the Pacific Coast from Cape San Lucas to Panama, and *E. flavilatus* is taken from Cape San Lucas to Mazatlan and beyond; also the somewhat pugnacious Black and White Damselfish (*Dascyllus aruanus*) and its relative, the Black Damsel (*D. melanurus*). The former is widely distributed, extending from the east coast of Africa through the Indian Ocean and the Indo-Malayan

Archipelago to Polynesia and New Zealand. The Black Damsel, which is slightly longer, reaching a length of two and one-quarter inches, is found in East Indian waters and eastward to the Caroline Islands and Melanesia. Both these little Damsel-fishes have creamy white bodies with three black cross bands, but in the Black and White Damsel the anterior band runs obliquely from the origin of the spinous dorsal fin through the eye to the chin and jaw, whereas in the Black Damsel the anterior band runs vertically from the crown of the head through the eye to the chin. All the tips of the fins are yellow in the Black and White Damsel, whereas the caudal fin is black and the pectorals and ventrals dusky in the Black Damsel.

The Sergeant Major and Silver Moonfish (the latter of another family) are found on both coasts of tropical America and therefore are as available for San Francisco as for New York.

Besides the Pomacentrids are the Moorish Idol (family Zanclostidæ), the Gobies, Sculpins, vivid red and green Kelpfishes, Rainbow Perch and other viviparous Perches, and many others. None of these more bizarre than the Moorish Idol (*Zanclus cornutus*), widely distributed in the waters of southern California, Hawaii, Samoa, Galapagos, Polynesia and the East Indies. It was named in 1758



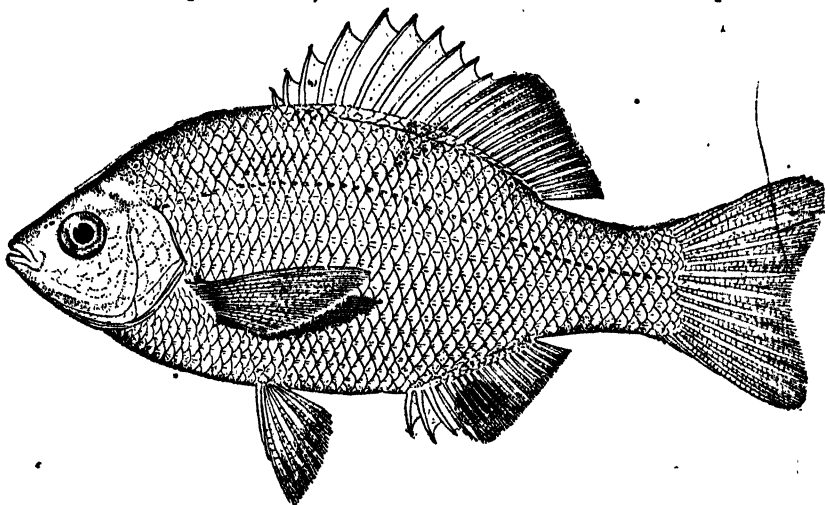
Courtesy California Academy of Sciences, Steinhart Aquarium

The Moorish Idol is both bizarre and peaceable. It is widely distributed in the waters of southern California, Hawaii, Samoa, Galapagos, Polynesia and the East Indies, and makes an ideal aquarium fish.

by Linnæus, who called it Horned Chætoðon because of the small hornlike processes on the head. The snout is long and pointed and the dorsal fin carries a trailing filament. The pale yellow, almost circular body is banded vertically with wide stripes of black, and one of these on the caudal nearly covers that fin. The Moorish Idol has a mild disposition. Its maximum length is seven inches.

SURFFISHES

The Pacific Coast Surffishes (family Embiotocidae) include several interesting members, most desirable for the home aquarium



Courtesy California Academy of Sciences, Steinhart Aquarium

The Least Perch is the smallest of the marine Surffishes, and very attractive for the circulated salt-water aquarium. Surffishes were the first viviparous fishes known, and their discovery created considerable excitement in the scientific world.

being the little Viviparous Perch (*Cymatogaster aggregatus*) with a maximum length of six inches, and ranging from Alaska to Todos Santos Bay; and the Striped Surffish or Rainbow Perch (*Tæniotoca lateralis*), ranging from Vancouver Island to Todos Santos Bay. The former is very dark during the mating season, when many males don a black velvet tuxedo, and the latter, richly trimmed with bright blue, is called the prettiest of Surffishes. Another Surffish suitable for the home aquarium is the Least Perch (*Apeona minima*), found com-

monly along the California coast from San Francisco to San Diego, where it lives in rock pools, feeding on seaweeds and minute crustaceans. In the aquarium it will take live brine shrimps and other foods. It is an active fish with a maximum length of six inches. The body color is olive green above, with bluish reflections, and a number of black dots appear on the sides, which often are yellowish. There is an irregular longitudinal black band along the axis of the body, and two vertical dark bars run downward from the base of the dorsal fin, on which they appear as blotches. The axil of the pectoral is black, and ventral and anal fins are tipped with black. (Bibliography No. 991.) These live-bearing Perches are fry-eaters from whom the young must be protected from the instant of birth. They were the first viviparous fishes known, and their discovery created considerable excitement in the scientific world.

GOBIES AND SCULPINS

Among Pacific Coast Gobies are the Long-jawed Goby (*Gillichthys mirabilis*), so called because the jaw grows longer as the fish matures, until it measures one-third the entire length of the animal. This species lives near the shore among the marine algæ and is fond of burying itself in the sand.

The Smooth Sculpin or Smooth Cabezon (*Leptocottus armatus*), when small, is a desirable species for the home aquarium, though it attains a length of 12 inches in a state of nature. It is found from Kadiak to San Francisco and is very common in its northern range.

• CHÆTODONS OR BUTTERFLY FISHES •

The Butterfly Fishes (Chætodontidæ) are among the most richly colored of coral reef fishes, active, graceful, desirable for the home aquarium, and identified by their greatly compressed, disc-shaped bodies. Among these are the Nu-ku-nu-ku and its cousin, the La-u-ha-u.

The Nu-ku-nu-ku (*Forcipiger longirostris*) is a strikingly beautiful little creature, easily identified by its long, slender snout and brilliant yellow color. The upper part of the head is black, and there is a black spot under the tail. The long snout is serviceable in picking out its prey from interstices in the coral reefs. In the aquarium it likes live brine shrimps and takes also prepared foods. Nu-ku-nu-ku is an abbreviation of the name by which it is known among South Sea Islanders—La-u-wi-li-wi-li-nu-ku-nu-ku-o-e-o-e.

The La-u-ha-u (*Chætodon setifer*) has a deep, narrow body,

with rows of scales on the anterior part which run upward and backward, each marked by a dark line. Those of the posterior part of the body run downward and backward almost at right angles. The pointed snout is characteristic of the Butterfly Fishes (called also Coral Fishes), as are also the bristlelike teeth, used in browsing on the coral polypes. The first ray of the soft dorsal is elongated and a wide black stripe runs through the eye.

SEA HORSES, PIPEFISHES AND TRUNKFISHES

The Australian Sea Horse (*Hippocampus n. hollandiæ*) reaches the aquarist on the Pacific Coast, and Pipefishes and Sea Horses are present in California waters. Some of the Pipefishs breed



Photograph by Carl Rabe

Hawaiian Trunkfish in the Steinhart Aquarium. Above, Australian Sea Horses with tails coiled about the branches.

over a large part of the year and one may secure young specimens of the Short-nosed Pipefish (*Syngnathus arctus*) or the Common Pipefish (*S. leptorhynchus*); also, if lucky, a very young specimen of the somewhat rare Giant Sea Horse (*Hippocampus ingens*) which extends from San Diego to Mazatlan, and reaches a length of 12 inches. (This group requires live food.)

Small specimens of Trunkfishes from tropical seas also may be kept in the home aquarium, as *Ostracion sebæ* of Hawaii, the East

Indies, Melanesia and Polynesia. An oblong bony box encases the body, but the strong tail makes up for the rigidity of the trunk and speeds the little fish about in search of its living.

WRASSE FISHES AND SCORPIONFISHES

Among the beautiful red and green Wrasse fishes or Kelpfishes of California is the Señorita or Kelpfish (*Iridio semicinctus*) which is called also Doncella and ranges from the Santa Barbara Islands to Cedros Island.



Photograph by Carl Rabe

Most picturesque of Scorpionfishes is the Turkey Fish. Its dorsal spines are connected with poison glands capable of inflicting a painful if not fatal injury. It has the reputation of hypnotizing its prey.

Most picturesque of Scorpionfishes (Scorpenidae) is the Turkey Fish, Lionfish or Zebra Fish (*Pterois volitans*) of the Indian Ocean, Australian, Samoan, Fijian and other tropical Pacific coral reefs (called also Butterfly Cod in Australia). The long, winglike rays of the dorsal and pectoral fins give the scientific names, which mean winglike, flying about; and the resemblance to a young turkey displaying his plumage gives the common name of Turkey Fish by

which it is known throughout its range.* The body and head are striped with red, white and brown, the fins are yellow, spotted with brown or black, and there are dermal flaps on the cheeks. The dorsal spines, however, are connected with poison glands and are capable of inflicting an excessively painful, if not fatal injury. A nine inch specimen has a fin spread of 10 inches. Live food is the natural fare, and Guppies, Mosquito Fishes, Killies and the like are relished, but it will take also strips of meat and fish. It has the reputation of hypnotizing its victims, which it approaches with a quivering of the fins that appears to fascinate them until the huge mouth opens and a current of water flows in, carrying with it the unresisting prey. Three other species, *P. zebra*, *P. brachyptera* and *P. heterura* are found in the Indian Ocean and Malay Archipelago.

All the species listed for the balanced aquarium on the Pacific Coast may, of course, be maintained as well in running water.

GULF COAST FISHES

895. Which fishes can be kept in a circulated salt-water aquarium on the Gulf Coast?

Two Pipefishes of the genus *Syrristes*, *S. scovelli* of the Texas coast and found also on both the east and west coasts of Florida, and the Louisiana Pipefish, *S. affinis*, are quite to be coveted if one can supply them with live food. Their cousins, the Sea Horses, also live in the Gulf of Mexico. The Pigmy Sea Horse (*Hippocampus zosterae*), smallest of Sea Horses, is two inches long and is indigenous to Pensacola Bay; and the Frilled Sea Horse (*H. styliger*) appears as though adorned with tiny seaweeds as it swims, trailing its numerous filaments. It inhabits both coasts of Florida.

One of the most desirable species is the Common Pompano (or Pampano—*Trachinotus carolinus*), which, for silvery beauty and activity, can hardly be excelled. It is resident along the coast of Texas, "where it moves in and out with the tides and plays about the passes." It spawns in Texas in April, in the Gulf in May and June, and very small specimens may be found during the summer in the surf along the beach.

The Snappers grow too large for a home aquarium but one may find very small red-finned Muttonfishes (*Lutianus analis*) about Pensacola.

The Pigfish or Red-mouthed Grunt (*Orthopristis chrysopterus*) is representative of the grunts along the Gulf Coast and is one of the hardiest of the family, surviving for three years in the aquarium.

The Pinfish (*Lagodon rhomboides*), called also Sailor's Choice, represents the Porgies.

Among the Pomacentrids, beautiful but quarrelsome little Gregories may be found, as the Beau Gregory (*Eupomacentrus leucostictus*), often taken on the west coast of Florida. The body color is blue, belly yellow, though the colors vary with conditions, excitement bringing out brilliant hues, confinement in an aquarium often causing them to fade.

The Wrasse fishes are represented by the pretty little Razorfish



From Nature's Wonderland, by Kingsley and Breck

Pipefishes and Sea Horses

These fishes are distant cousins, and the male in each species carries the eggs in a brood pouch. The Frilled Sea Horse lives in the Gulf of Mexico and is found also in the Gulf Stream.

(*Xyrichthys psittacus*), taken about Pensacola and with body compressed like that of the *scalare*.

Two Parrotfishes occur in moderately deep water in the Gulf of Mexico, Evermann's Parrot (*Scarus evermanni*) and its cousin, Bollman's Parrot (*S. bollmani*).

The Trunkfishes are present also, in the form of the Cowfish or Horned Trunkfish (*Acanthostracion quadricornis*), occasionally taken at Pensacola, Florida, and Galveston, Texas, and young specimens of which are much to be desired.

Puffers, too, may be looked for on the Gulf Coast, the Southern



Photograph by Elwin R. Sanborn

The Common Pompano is resident along the coast of Texas, and spawns in the Gulf in May and June. Very small specimens may be found in summer in the surf along the beach. Schools of young individuals also are carried by the Gulf Stream as far north as New York. For silvery beauty and activity, they can hardly be excelled. •

Puffer or Swelltoad (*Sphoeroides spengleri*) living in Texas and Florida waters. This species is spotted with black, the adults commonly being smooth, while the young are somewhat horny.

The Spot (*Leiostomus xanthurus*) is taken on the Gulf Coast (see Nos. 882, 889), also, the Slippery Dick or Sand Eel (*Rissola marginata*). (See 882.)

These are a few of the commoner fishes available for the circulated aquarium along the Gulf Coast.

896. What food should one give the aquarium fishes of the Gulf Coast?

They like fish and shellfish, and will take the food described in Nos. 187 and 188.

HEATED, CIRCULATED SALT-WATER AQUARIUM

897. How can the water be heated and circulated in a salt-water aquarium in the home?

It can be heated with an electric heater thermostatically controlled to maintain the desired temperature. Modern methods have been invented for meeting the need to circulate and cleanse the water, with a small pump and filter.

898. Which fishes can be kept in a heated salt-water aquarium with circulation?

Tropical salt-water species of small size. For persons living in the latitude of New York, those taken from Florida, West Indian and Bermudian waters are most suitable, though Turkey Fishes and others from the Pacific also may be had.

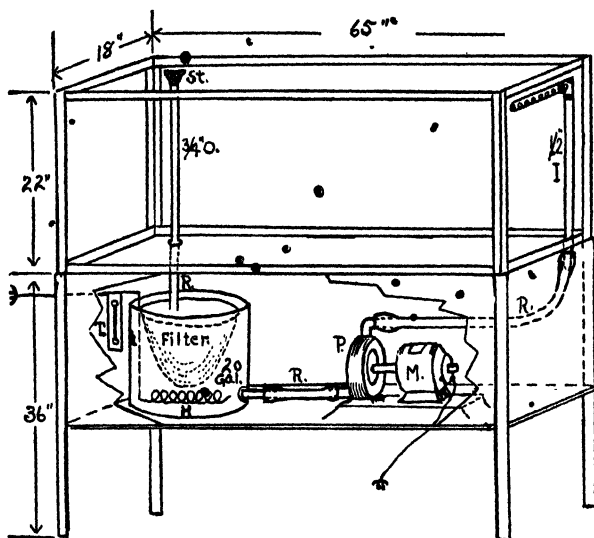
An even temperature of from 72° to 74° should be maintained.*

899. Should salt-water tropical fishes be sterilized before introduction into the aquarium?

Yes. They cannot conveniently be quarantined for observation, like fresh-water species, for few people will have a spare salt-water receptacle to serve this purpose, yet it is necessary to make sure they are not infested with parasites, which spread rapidly and may wipe out one's collection.

Some tropical Atlantic fishes are parasitized by a fluke (*Epibdella melleni*), which attacks their bodies and does not spare their

* All temperatures are Fahrenheit.



Designed by Robert J. Lanier

A closed circulating system for a heated or unheated fresh- or salt-water aquarium in the home, showing tank with compartment beneath equipped with filter, H—electric heating coil, T—thermostat, R—flexible rubber tubing, P—pump, M—motor, I—inlet pipe, O—outlet pipe, St—standpipe with strainer. (The thermostat may be set inside receptacle containing filter.)

eyes, and one must avoid introducing it into the aquarium as one would avoid introducing argulids into a garden pool.

Fill two enamel buckets with tap water and allow to stand for 24 hours (so that there will be no chlorine present). Salt the water in each bucket by adding three tablespoons of pure salt (sodium chloride) to the gallon. With the water in one of the buckets, make a 10% solution of silvol (not argyrol), in which immerse the fishes for from one to three minutes. Transfer them to the other bucket containing only salted water, to permit the chemical to wash off their bodies. They are then ready to be introduced into your aquarium. (See also No. 967.)

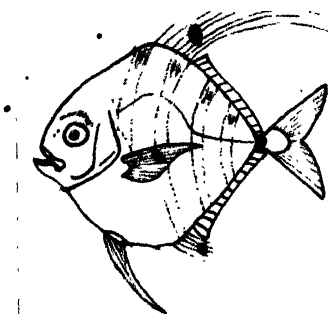
900. Which are the prettiest and most interesting of small Florida, Bermudian and West Indian salt-water fishes?

Many alluring little fishes of the tropical Atlantic can be maintained locally in unheated aquaria, and in heated aquaria in the northern states. Among those commonly available are the following:

SQUIRRELS, COBBLERFISHES AND CARDINAL FISHES

(FAMILIES HOLOCENTRIDÆ, CARANGIDÆ AND APOGONIDÆ)

Among the Squirrelfishes is the Red Squirrel (*Holocentrus ascensionis*), found in the waters of Florida, Cuba, and south to St. Helena and Ascension Islands, and remarkable for its large eyes and, under the excitement of captivity, salmon red coloration. Squirrelfishes, however, have sharp spines on their gill covers with which they hurt one another unintentionally when frightened.



After Hugh M. Smith

The Threadfish or Shoemaker (*Alectis crinitus*)

The dorsal and anal filaments are enormously extended, and in young specimens may measure twice the length of the body.

The Threadfish or Shoemaker (*Alectis crinitus*), though uncommon north of Florida, sometimes strays to New York and Massachusetts. Young specimens require a spacious tank, for the enormously extended rays of their dorsal and anal fins may measure twice the length of the body. Though decidedly picturesque, the filaments are believed to be very much in their way, and are shortened, apparently by wear and tear, as they grow older. The golden yellow body is bluish above, with a dark blotch on the opercle, also on the dorsal and ventral fins. The maximum length is 12 inches. Other names are Sea-hen, Sea-cock, Fish-cock and Cobblerfish. *Alectis* means chicken-cock, *crinitus* means covered with hair (in allusion to the hairlike threads which trail behind the little fish).

The Marine Goldfishes or Cardinal fishes are attractive, particularly *Apogon sellicauda* and *A. maculatus*, the former somewhat rarer than the Gregorys though not less hardy (average length four inches), the latter (which sometimes ranges north to Cape Cod) two and one-half inches.

BIG EYES, SNAPPERS AND PORGIES

(FAMILIES PRIACANTHIDÆ, LUTIANIDÆ AND SPARIDÆ)

Among the Big Eyes or Catalufas is the Redfish (*Pseudopriacanthus altus*), which has drifted north in the Gulf Stream from the West Indies to Narragansett Bay and is notable for its immense eye and scarlet color. It has survived for 16 months in captivity and though it may reach 11 inches, most specimens do not average over six inches.

Some of the Snappers are pleasing, notably the Yellowtail or Rabilubia (*Ocyurus chrysurus*), which is green, tinged with violet and yellow, and has a red iris, and the Schoolmaster (*Lutjanus apodus*), both of which wander north to Cape Cod though their normal range is from Bahia through the West Indies and to Key West. They will survive for three or four years in captivity though called "deep-sea snappers." The long, pointed snout of the Schoolmaster displays four canines in the upper jaw; the color is greenish, sometimes with vertical bars, and the fins are purple and orange yellow.

Various Porgies may be kept when small, such as the Pinfish (*Lagodon rhomboides*), which extends from Cape Cod to Cuba and is common also on the Gulf Coast. A pretty little fish of yellowish silver, it is distinguished by two thumb marks, one on the pectoral fin, the other between this and the eye.

GRUNTS AND WRASSE FISHES

(FAMILIES HÆMULIDÆ AND CORIDÆ)

There are various species of Grunts, all with blood-red mouths, as the Red-mouthed Grunt (*Orthopristis chrysopterus*), common on South Atlantic and Gulf Coasts, and the young of which, like those of the Pompano, are carried north to New York in summer in the Gulf Stream; the Blue-striped Grunt (*Hæmulon sciurus*), a hardy, handsome fish which has survived for five years in captivity. The sides are brassy yellow, with 12 wavy, sky blue stripes on the head and body, yellow fins and a golden iris; the Black Grunt or Cæsar Grunt (*H. carboarium*) of smaller size (maximum length 10 inches), which is

light blue gray with seven or eight yellow stripes and bright yellow fins; the Porkfish (*Anisotremus virginicus*), a handsome fish with yellow background richly striped with blue horizontally and with two black vertical bands through the eye and behind the opercle. It will survive for over one year in captivity, and though its maximum length is one foot, six to eight inches is the average length and smaller specimens may be taken; and the Tom Tate, including the White Grunt (*Bathystoma striatum*) of blue and silver striped with gold, also having a red mouth.

The Wrasse fishes are of many kinds, including the round bodied, gliding Slippery Dick (*Iridio bivittata*), with an average length of five inches and a survival record of two years, small specimens of the Puddingwife (*I. radiata*), which has a maximum length of 18 inches, and the Reef Fish (*Thalassoma nitidum*) and Bluehead (*T. bifasciatum*), averaging five inches and regarded by some collectors as the same species. They differ in color when taken at different depths, a phenomenon not uncommon in tropical Atlantic fishes. In the Bluehead phase the yellowish body is offset by a bright blue head. These are slender, active little fishes, and may last for upwards of one year in the aquarium.

BUTTERFLIES, SURGEONS, POMACENTRIDES AND PARROTS

(FAMILIES CHÆTODONTIDÆ, ACANTHURIDÆ, POMACENTRIDÆ, SPARISOMIDÆ AND SCARIDÆ)

The Chætodons include the Butterfly Fish (*Chætodon bimaculatus*) which is native to the West Indies, and for a small fish is a large traveler, having been noted in East Indian waters and not infrequently journeying north in the Gulf Stream to New Jersey and Rhode Island. It will live two years in captivity. Its cousin, the Four Eyes (*C. capistratus*) is handsomer but not as hardy. Both these Chætodons have a black band running from the lower edge of the gill covers upward through the eye and backward to the beginning of the dorsal fin, but the Four Eyes is immediately distinguished by a large black, almost circular spot near the tail, ringed with white and so eyelike that at first glance one does not know which is the head of the fish and which the tail. The black spot is present also in the Butterfly Fish, but it is located at the lower rear of the dorsal fin and is without the ring. These fishes average five inches. Their relatives, the Angelfishes, also are desirable when of small size, though not noted for angelic dispositions. They include the Black Angel, French Angel, Blue Angel, Queen Angel, Yellow-tail Angel and others, and are notable for their elliptical

bodies and the long pointed rays of the dorsal and anal fins, which sometimes extend beyond the tail. In the Blue Angel (*Angelichthys ciliaris*) the head is yellow though the spines on the gill covers are blue, the body is grayish blue and the fins ultramarine blue, tipped with yellow. In the Black Angel (*Pomacanthus arcuatus*), the slate gray body is completely peppered with small round black spots. In the French Angel (*Pomacanthus paru*), the black body is marked with innumerable small white vertical lines, each shaped like a parenthesis.

The Surgeonfishes include the Blue Tang or Blue Surgeon (*Acanthurus caeruleus*), an herbivorous little fish armed with a sharp defensive spine on each side, at the base of the caudal fin, desirable for the home aquarium only when very young. The color is a rich brownish blue.

The Demoiselles or Pomacentrids include the Sergeant Major and the Gregories. The Sergeant Major (*Abudefduf marginatus*) is



Photograph by S. C. Duntun

The Sergeant Major (*Abudefduf marginatus*) is found on both coasts of tropical America, is very active and playful, also quarrelsome. The attention of the specimen at the left is riveted on the contortions of a Sea Horse winding itself about a bit of sea-wrack. Note the Sea Anemone at the right.

found in great numbers scattered about the coral reefs and also near the shore. Its vivid black and lemon velvety bands change to lighter black and bluish yellow in captivity, though it remains active and playful and will survive for upwards of two years. Specimens one-half inch in length are taken in Cuban waters. The Beau Gregory (*Eupomacentrus leucostictus*) and Brown Gregory (*E. fuscus*) will



Courtesy Emilio Masnata

Interior of the Hermanas Masnata Aquarium at Havana, showing exhibition tanks of pigmy marine fishes from Cuban waters.

live for three years in captivity, have a fighting nature, and get along best each by itself or with a fish of the opposite sex, though the sexes are not easily determined unless one finds a pair together and nets them. The maximum length of these three species is six inches. Mr. C. H. Peters (*Home Aquarium Bulletin*, July, 1934) relates that the Brown Gregory can be maintained in fresh water, his information being that it breeds in the warm, spring-fed rivers of Cuba. He calls this species by the Cuban name of Blue Devil, given because it is blue when young and has a devilish disposition; and in his experience no two young specimens can be kept together. In public aquariums the adults commonly are grouped, also with Sergeant Majors and Beau Gregories; but Demoiselles naturally live either singly or in pairs, and unless placed in a spacious tank and provided with hiding places, such as large stones, they will fight until only one or one pair remains. Other charming Demoiselles, the Starry-backs, of the genus *Stegastes* (formerly *Microspathodon*), have backs dotted with glittering blue specks like stars in a midnight sky.

There are many small species of Parrotfishes, most of which are handsomely colored and which range from the West Indies to Brazil, as the Red or Roseback Parrot (*Sparisoma abildgaardi*), the Green Parrot (*S. viride*), the Mud Parrot (*S. flavescens*), the Scotch Porgy (*S. hoplomystax*), the Rainbow Parrot (*Pseudoscarus guacamaia*), which has a bright blue beak, the Blue Parrots (*P. plumbeus*, *Scarus vetula*, and *S. cæruleus*), the Harbor Parrot (*S. croicensis*), and the Rosy-sided Parrot (*S. punctulatus*). The hardiest of these is the Green Parrot (*S. viride*), which has survived for over two years in captivity. Parrotfishes are so called because of their beak-like mouths, which are fitted with small mosaic teeth. These fishes require Sea Lettuce and other marine algæ as they are largely herbivorous, though garden lettuce may be substituted in a prepared food. (See No. 188.)

BLENNIES, FILEFISHES AND TRUNKFISHES

(FAMILIES BLENNIIDÆ, MONACANTHIDÆ AND OSTRACIIDÆ)

The Blennies include the Molly Miller (*Blennius cristatus*), which is dark brown or black, scaleless, and has a peculiarly high head with the eyes at the top. It is only four inches at maximum. Another of the Molly Millers, called the Tide-pool Blenny (*Salariichthys textilis*), is of a rich green or purple shade, vertically banded with black. It also measures but four inches, and has survived in captivity for 12 months.

ABOUT YOUR AQUARIUM

The herbivorous Filefishes include the Orange Filefish or Foolfish (*Ceratacanthus schæpfi*) when very small (it reaches a length of two feet). It will survive three years if some vegetable substances are included in the diet, its principal food being marine algæ; also its less hardy cousin the Unicorn Fish (*Osbeckia scripta*).

The Trunkfishes include the Common Trunkfish (*Rhinesomus triqueter*), the Buffalo Trunkfish (*Lactophrys trigonus*), with a strongly humped back, and the Cowfish (*Acanthostracion quadricornis*) with fascinating little "horns," all able to survive for two years in the aquarium. The body of the Trunkfishes is encased in a bony box. Two inch specimens are greatly to be desired, the average length being six inches.

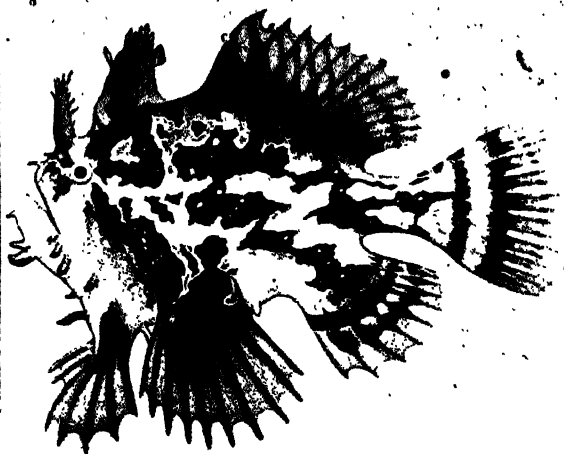
FROGFISHES

(FAMILY ANTENNARIIDÆ)

Sargassumfishes or Mousefishes are pelagic species which drift to many shores far distant from their home in the Sargasso Sea and have been taken in the latitude of New York and even on the coast of Norway, drifting in gulfweed to which they are able to cling and in which they climb about like mice. Sometimes they are jokingly called Peter O'Phryne, a mispronunciation of their former generic name of *Pterophryne*. The present generic name of *Histrio* means harlequin. They are recommended for the heated aquarium, though able to adapt themselves to almost any water temperature. *Histrio pictus*, called the Sargassumfish, Mousefish, Toadfish and Marbled Angler (the last name refers to the yellow body marbled with brown), reaches a maximum length of six inches. Mousefishes, like other Frogfishes, catch their prey by waving a fleshy bait. In *H. pictus* this bait has a bifurcated tip. *H. gibba*, the Common Sargassumfish, seldom is seen over two inches in length but is said to attain a maximum length of 15 inches. In this species the bait is bulbous. *H. jagua*, the Brown Mousefish, with a maximum length of four and one-half inches, is chocolate brown in color, spotted with white, and in this species the bait is pointed. The grasping pectoral fins of the Mousefishes are like little hands with 10 fingers. (Bibliography No. 31.) Mr. Emilio Masnata of Havana, Cuba, has maintained Sargassumfishes on a diet of Guppies and frequently has in his aquarium specimens from one to four inches in length. He has found them to be great cannibals, and a collection of 300 Mousefishes soon numbered but 150.

Other Frogfishes, similar to the Mousefishes, are those in the genus *Antennarius*, which comprises some 16 species found on both

coasts of tropical America, in the Caribbean Sea, around Porto Rico and Cuba, the Santa Barbara Islands, Bermuda and Barbados, and at least one specimen has been taken drifting in seaweed in the Gulf of Mexico. They have a simple bait, used for catching small live prey, lead lives very similar to those of the Mousefishes, and are distinguished by a prickly skin.



Courtesy John G. Shedd Aquarium

The Sargassumfish (*Histrio pictus*)

The generic name, *Histrio*, means harlequin. The maximum length is six inches, and the little fish lives in the sargassum weed in which it crawls about like a mouse and in which, also, it sometimes drifts to distant shores. By waving a fleshy bait at the top of the head it attracts its prey, and readily swallows its own brothers and sisters.

These are a few of the prettiest and most attractive of Florida, Bermuda and West Indian species commonly brought to public aquariums in the northern and middle western states, and all should be obtained when of small size.

There are many others, of still smaller maximum size, much to be coveted but little to be hoped for, as they seldom are taken and have not yet been transported north. Among them are two living emeralds. The Pigmy Wrasse fish (*Doratonotus megalepis*), ranging from Key West south to the West Indies and related to the Reef Fish and Bluehead, with an average length of two inches and a maximum of three, is a beautiful green, with saillike dorsal and anal

fins, and a large, rounded tail. The Emerald of the Sea (*Erotelis smaragdus*) is a Goby, frequenting the algæ on coral shores and known from Key West to Cuba. Handsome but difficult to obtain, their longevity and hardihood have not been recorded.

SMALL BRACKISH WATER SPECIES OF THE NORTH ATLANTIC

901. What is brackish water?

It is a mixture of salt and fresh water, having a specific gravity ranging from the slightest amount of salt to about 1.016. Brackish water, therefore, is the water of the sea where it meets the water from the rivers.

902. Which little aquarium fishes will one find commonly in the brackish waters of the north Atlantic Coast?

One will find a dozen or more kinds of Killifishes, including the Sheepshead Minnow, Rainwater Fish, Common Killie, Bass Killie, and Fresh-water Killie. Also Sticklebacks, including the Nine-spined Stickleback (*Pungitius pungitius*), called also the Ten-spined Stickleback and described under fresh-water Sticklebacks, Nos. 794, 795, the Two-spined, Three-spined and Four-spined sticklebacks. The American Sole is another desirable species, commonly kept in fresh-water aquaria under the name of Aeroplane Fish. All of these will live in the temperature of the living room, 68° to 72°.*

KILLIFISHES

(FAMILY CYPRINODONTIDÆ)

903. What are the range and habitat of the Sheepshead Minnow (*Cyprinodon variegatus*)?

This little fish, called also Sheepshead *Lebias*, Pursy Minnow and Variegated Minnow, ranges from Cape Cod to the Rio Grande and Mexico. The scientific name means Variegated Tooth Carp. Cyprino is from the Greek *kyprinos*, carp, and *dont* means tooth. (Other Killies of this genus are found along the Gulf Coast, and in fresh water from Nevada and California to Mexico.)

The Sheepshead Minnow lives in brackish water, ditches, salt-water ditches, shallows, creeks, marshes, along weedy shores, also in estuaries, as it enters streams. Between April and September it inhabits shallow water in the latitude of New York. From Novem-

* All temperatures are Fahrenheit.

ber to March it swims with other Killies in creeks and marshes. The name of Sheepshead Minnow, by which the species now is known throughout its range, was applied to it because of the head's fancied resemblance to that of a sheep.

904. What are the colors and breeding habits of the Sheepshead Minnow?

As the specific name indicates, it is a variegated little fish, silver and black, the male having seven or eight cross bars on his back and two black cross stripes on the caudal fin, more noticeable in breeding time. The female is plain silver, with uneven faint black vertical markings. The male, in the breeding season, becomes gorgeously arrayed in orange, blue and black. His sides and back are tinged with a brilliant, ultramarine blue, the lower part of his body assumes a dull orange, a black half-ring forms around each eye, and touches of black appear on the edges of his fins. On the female, a black spot will be noticed at the back of the dorsal fin.

The females are longer than the males, averaging three inches, while males seldom exceed two inches. They are stocky little fishes, with full sides, square tails, and no lateral line.

They spawn from April to September in shallow water and in the aquarium. The male is a rough wooer, from whom the female sometimes is glad to hide behind a bit of sheltering vegetation.

The eggs are heavy and adhesive, sticking together by numerous threads and sinking to the bottom. They hatch in five days, and the fry are four mm. long. Their fins have developed at nine mm. and the adult characteristics are present at 12 mm.

The species is hardy and has been kept and bred in fresh water to which a little salt was added, two tablespoons to each gallon.

It is a shy, active little fish, given to schooling; a decided cannibal, but feeding also on vegetable substances and mosquito larvæ. It is inclined to be quarrelsome, but when a number are together, they dart at one another without inflicting any injury.

905. What are the range and habitat of the Rainwater Fish or Little Killifish (*Lucania parva*)?

It ranges from Connecticut to Key West, Texas and Mexico, along the coasts, entering almost fresh water, but will be found in the shallows along shore, in bays, brackish ponds and ditches among aquatic plants, and in extremely shallow water. It is not easily captured.

906. What are the colors and spawning season of the Rainwater Fish?

This fish has very tiny scales set off conspicuously with dark rims, presenting a pretty combination of silver and black. Specimens found in southern waters are quite brilliant.

Spring is the spawning season and the eggs hatch in about 14 days.

The Rainwater Fish generally attains a length of about one and one-half inches, with a maximum of two.

Its natural food consists of salt-water Cyclops, *Gammarus*, and other minute living creatures.

907. What are the range and habitat of the Common Killie or Mummychog (*Fundulus heteroclitus*)?

This Killie, often called by its generic name, *Fundulus*, ranges from the coast of Labrador to the Rio Grande and along the Gulf Coast. A northern variety (*F. heteroclitus macrolepidotus*), known as the Common Cobbler, is found in coastal waters from Maine to Virginia, and a southern variety (*F. heteroclitus bermuda*), known as the Mangrove Minnow, is a native of Bermuda waters. (There are other varieties found in the Gulf of St. Lawrence, on the Gulf Coast, in the West Indies and elsewhere.)

This species swarms in brackish and salt waters, and ascends streams. Its preference is for Eel Grass and mud, one of its names being Muddabbler. From November to March, in the latitude of New York, it swims with the Sheepshead *Lobias* in creeks and marshes. It is exceedingly abundant in the Potomac.

908. What are the colors and breeding habits of the Common Killie?

The female is brown, with 15 dark cross bars, and the young resemble her. The male is dark green, nearly black, above. In the breeding season he is orange yellow below, with glints of blue and vertical silvery bars. Those living in southern waters are more conspicuously colored.

The eggs are laid late in the spring, and the young, hatching in early summer, are able to shift for themselves. They swarm in great schools in Eel Grass and on sandy beaches with other little fishes.

The adults reach a length of six inches.

This is a hardy little fish, withstanding drastic changes of

salinity when these are voluntary and able to survive even in foul water. When placed in a fresh-water aquarium, it quickly develops fungus. It is considered one of the most valuable of mosquito destroyers, and is much in demand by people who own marsh lands.

Its natural food is made up of a varied diet of tiny crustaceans, mollusks, annelids, insects (particularly mosquito larvæ in brackish marshes), small fishes, algæ, and its own eggs. From the sand it extracts all sorts of little eggs and foraminifera.

909. What are the range and habitat of the Bass Killie or Mayfish (*Fundulus majalis*)?

This little fish is found from Massachusetts to Florida. It lives in bays, coves, creeks, tide-pools and marshes, and may be found in company with the Common Killie, often schooling. It seldom leaves salt or brackish water.

910. What are the colors and habits of the Bass Killie?

The male has grayish silver sides, with a dozen or more vertical bars, a black ocellus on his dorsal fin, and a brown iris. In the breeding season his fins are tinged with chrome yellow. The female has one narrow black longitudinal stripe at the eye level, and two below this. This Killie is slenderer than the Common Killie, has a more pointed snout, is more silvery, and its bands are conspicuous.

It grows large for a Killie, the male reaching six inches, and females measuring eight inches have been recorded.

The yellow eggs are laid in sand at high tide.

The "homing instinct" of the Bass Killie is an interesting trait. If placed from five to 20 feet from the water, it will reach it by a series of jumps. Unfortunately it is not hardy in captivity.

For food, it swallows sand and vegetable debris, thus extracting microscopic organisms of many kinds, preys on shrimp eggs, insect larvæ, mollusks, crustaceans, and annelids.

911. What are the range and habitat of the so-called Fresh-water Killie (*Zygonectes diaphanus*)?

This species ranges from New Brunswick, Canada, to Wilmington, North Carolina. It inhabits brackish water and ascends streams, like most other salt-water Killies. Above tide water it congregates in immense schools together with the Silverfin, another little fish found in both fresh and brackish waters. A western variety, *Z. diaphanus menona*, ranges in lakes and streams from Ohio to Iowa, Minnesota and South Dakota.

912. What are the colors and foods of the Fresh-water Killie?

The male is marked with 20 silver vertical bars, the female with 15 to 25 dark similar bars. In the breeding season (summer) the male develops silver cross bands, and a purple spot is noticeable on the opercle, on a line with his eye.

The young are marked like the female, and have pale green bodies. Their colors change when they are about two inches long.

The adult maximum length is four inches, but most specimens taken are much smaller.

Four-fifths of the natural food consists of snails, insects and crustaceans, and one-fifth of filamentous algæ. It is a well known destroyer of mosquito larvæ.

It is less hardy than the Common Killie, but has survived in captivity for three years, under favorable conditions, and will leap out of the water for its food.

It is distinguished from the Common Killie by the smaller, transparent scales, hence the specific name, *diaphanus*, and another common name, the Translucent Killie.

STICKLEBACKS**(FAMILY GASTEROSTEIDÆ)****913. What are the spawning habits of the Sticklebacks?**

The nest-building habits of the various species are similar, though the shape of the nest differs. In some species it resembles the nest of a sparrow, in others it is spherical, or like an oriole's nest, with one or two holes for entrance and exit. Nests usually are constructed of pieces of algæ glued together by a secretion from the kidneys, which develops in the male fish coincidentally with the ripening of the milt. A place is selected among the stems of aquatic plants, where the water flows gently, and openings are placed in the direction of the current so that a steady stream is directed over the eggs. The nest frequently is weighted with sand or pebbles conveyed thither in the mouth of the male.

When the nest is ready, the male, in brilliant courting colors, with a blue or green back and often appearing to have donned a scarlet vest and tie, coaxes the female to deposit her eggs, which he at once fertilizes by casting his milt over them. She is then driven off while he seeks another mate, whose eggs are added to those of the first. One nest may contain the eggs of three females, and the same female may lay her eggs in more than one nest; but if she approaches the nest again after spawning, she pays for her temerity

with her life. In the breeding season, one may see floating in the shallows the bodies of many little females whose mates have inflicted capital punishment as the price of curiosity. The male defends his nest vigorously against all intruders, watching constantly for any little fish's head to appear in the surrounding vegetation, when he darts after the offender, pokes it with his snout, and uses the sharp spines on his back if need be, to vanquish it. By keeping his pectoral fins in rapid vibration, he aerates the eggs and keeps them clear of sediment, working very hard in the balanced aquarium where there is no current to help him.

The young hatch in from eight days to two weeks, and are not permitted by the father to leave the nest, any attempt to do so resulting in their being replaced with his mouth.

In some cases the males have cared for their fry for a month before exhibiting a cannibalistic interest in them, but generally it is wise to remove the young to a separate aquarium about the time the father permits them to leave the nest—when about a week old.

The best foods for the fry are infusoria, baby fish foods, and later, *Daphnia*.

914. What does it mean if the Stickleback destroys his nest?

If the eggs addle, as sometimes happens in a balanced aquarium in spite of all his care, the male tears the nest to pieces and sends its contents flying in every direction, as though in anger. He may also demolish the nest when his duty of tending the youngsters is ended. It is therefore wise to watch his subsequent actions, lest one lose the fry.

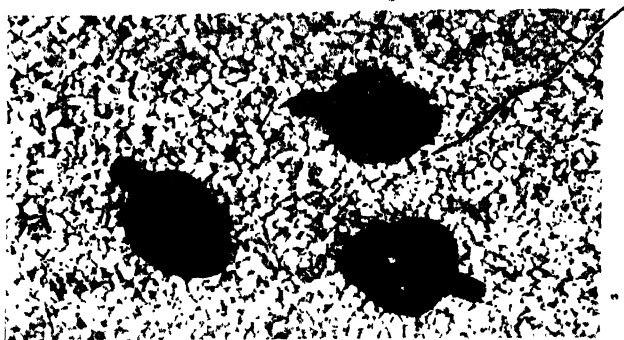
915. What are the foods of the Sticklebacks?

The natural food consists of insect larvæ, small crustaceans such as salt-water *Gammarus* and *Cyclops* and their eggs, infant mollusks such as squids, fish fry, diatoms and other minute organisms, also algæ. Some of the Sticklebacks eat the eggs of Trout and Salmon, and are of economic importance in this respect.

916. How are Sticklebacks distinguished from one another?

Usually by the number of their dorsal spines, from which they receive their common names.

Except in the breeding season, sexes are not easily distinguished. Males sometimes are aggressive out of season and may appear darker and slenderer.



Courtesy John G. Shedd Aquarium

The Hog-Choker or Aeroplane Fish (*Achirus fasciatus*) has no snout, its mouth is horizontal, and its eyes flat. It can hold to its support so firmly that to attempt to dislodge it is like trying to move a vacuum cup. Many Flounders assume the pattern of the surface on which they rest, as the fish at the upper right in the picture is doing.

It lives in shallow water in summer and often ascends sandy streams into fresh water, where it sometimes remains permanently. In the spring, adults are common on the fishing shores of the Potomac below Washington, District of Columbia.

The name of Hog-Choker was given this little fish because its hard, rough scales choke the hogs that attempt to feed upon it. It was described as early as 1815, but was not discovered as a home aquarium possibility until about 1932.

There are 13 species of Achiridæ or American Broad Soles, 10 in the genus *Achirus*. All are limited to the tropical Atlantic and Pacific except the Aeroplane Fish.

925. What are the colors and breeding habits of the Aeroplane Fish?

The color is variable, frequently dusky olive, mottled, with from six to 10 vertical stripes. In northern specimens the blind side shows round, dark spots.

Breeding occurs in late spring and during the summer, sexual maturity being reached when the fish is about four and one-half inches long. A female five inches long is said to produce 54,000 eggs. This species has not bred in captivity.

It is the smallest of American Flatfishes, averaging two inches in length and with a maximum of eight.

926. What are the characteristics of the Aeroplane Fish?

It is a harmless creature, a typical Flounder in form and habits, and called the closest relative of the European Sole in the waters of northeastern America. It is very tenacious of life, having been known to survive for four days out of water.

Its scales are small and rough on both sides of the body and fringed on the blind side. There is no snout, the mouth is horizontal, the eyes are flat, the upper one being in advance of the lower, and the upper jaw is longer than the lower. The body is deep and rounded. There are no pectoral fins, the caudal is round, and the dorsal and ventral fins reach from the front of the head to the caudal peduncle. There are many tentacles on the blind side of the head.

It is said by Fowler (*The Fishes of New Jersey*) that this fish bends itself up in an effort to resist a hog's determination to swallow it. It will hump itself up in the aquarium and can also hold to its support so firmly that to attempt to dislodge it is like trying to move a vacuum cup.

It lives chiefly on marine annelids, with a smaller percentage of crustacea, and algæ such as Eel Grass and Rock Weed.

Its maximum record of survival in captivity is two years in brackish water.

927. What foods are desirable for brackish water species in captivity, such as Killies, Sticklebacks and the Aeroplane Fish?

They like the usual fish foods such as chopped meat, fish and shellfish, also bread and boiled cereals, and are fond of insects, worms and small crustaceans.

HISTORY AND APPLICATION OF pH

928. What does pH mean?

pH stands for potential hydrogen. (This definition has been kindly verified by Dr. Victor E. Shelford of the University of Illinois, with the added explanation that "pH is the logarithm of the reciprocal of a normal hydrogen ion solution.").

The term "pH value" came into use in the study of soils, "sour" soil having been discovered to be acid, "sweet" soil alkaline. It became definitely known that acid soils might cause garden failures, that asters require one pH and cabbages quite another. Government and State agricultural stations began to test soils free, with remarkably satisfactory results to gardeners and farmers, who found that hydrated lime, ground limestone and ground oyster shells served as buffers against acidity, and that soils in which sulphate of ammonia supplied most of the nitrogen became more acid.

A soil testing unit, developed largely upon the ideas and suggestions of Prof. Edgar T. Wherry, was introduced to the market in 1919 by the LaMotte Chemical Products Co. of Maryland, enabling any farmer to test his own soil.

Long before this a few biologists had applied the principle to water, which is also acid, alkaline or neutral according to the concentration of its free hydrogen ions. As early as 1898 Jacques Loeb studied the effect of hydrogen ion concentration upon the rate of development in sea urchins. First with fisheries experts, later with aquarists, pH became the accepted symbol for hydrogen ion concentration of the water, this symbol having been suggested by Sören Peter Lauritz Sørensen of the Carlsberg Laboratory, Copenhagen, Denmark.

929. What is an ion?

In common parlance an ion is an electrified atom. Oxygen and hydrogen are chemically active in water because of the innumerable microscopic particles or ions animating them. An excess of hydrogen creates acidity in the water. Combined with oxygen the water becomes alkaline.

930. How did pH reach the amateur aquarist?

Papers written on the subject by members of the Bureau of Fisheries who, however, regarded pH as a fad as far as open waters

were concerned, came to the attention of Mr. W. G. O'Brien, chemist and aquarist of the Independence Nurseries, Ohio, who experimented with acid and alkaline water and believed he had discovered that certain fish parasites are destroyed and that ulcers and tail rot disappear in slightly acid water. He published his conclusions in *Aquatic Life*, April 1927. The O'Brien Aquarium Tester was announced shortly afterward by the LaMotte Chemical Products Co.

931. Is an understanding of pH necessary for success with aquaria?

Not for the fresh-water aquarium. pH is not in itself a complete index and therefore is not of the vital importance commonly represented; but it is well to understand the principle of pH in its broad application. The greatest successes in both private and public aquariums have been obtained by people who never referred to pH.

Mr. William L. Paullin, the first to breed *scalares* in this country, never applied the pH test to his aquaria. (*The Fish Culturist*, April, 1934.)

The Steinhart Aquarium, which exhibits the most colorful fishes shown in North America and which holds the record for longevity of specimens, never has applied the pH correction although its fresh water is naturally alkaline and many fresh-water fishes are supposed to do better in slightly acid water. At this aquarium it has been found that fresh-water fishes thrive for many years and enjoy excellent health in alkaline water. No Itch, tail rot, fungus or other diseases develop. Toy fishes commonly bred in slightly acid water have been bred there in alkaline water: *P. scalare* and *P. cimckei*, Fighting Fishes, *Danios*, Rosy Barbs, Red Tetra, *Hemigrammus caudovittatus*, *Astyanax bimaculatus*, Red and Black *helleri*, *Acara*, Jack Dempsey, Mexican Swordtail, Moonfish, Jewel Fish, *Panchax panchax*, *P. chapera*, *Apistogramma pertense*, *Limia vittata*, Mouthbreeders, *Corynopoma riisii*, *Æquidens latifrons*, Silver Tetra, and many others.

Human beings have died as a result of experimenting too nicely with very good dietaries, and it is quite possible to pH a fish to death.

The danger lies in ignorance of the factors which control acidity and alkalinity in the water. A direct correlation exists between pH values and the amount of submerged vegetation. The more vegetation, the higher the pH value, i. e., the more alkaline the water. Excrement of the fishes may raise the acidity or alkalinity of the water according to the food they eat.

Another example: If spring waters are acid or only slightly

alkaline, aeration and algæ remove the gases and the water becomes strongly alkaline.

932. How is the principle of pH applied to the aquarium?

The acidity or alkalinity of the water is determined in the pH test by the use of analine or other dyes, comparing the color reactions with charts, sealed test tubes or stained glass of standard colors.

The amount of water to be introduced from the aquarium is indicated on a graduated test tube, and to this is added the dye, usually 10 drops in 10 cc. of water. The color reaction then is compared with the hydrogen ion scale of color provided with the testing set. Neutral is rated at 7.0. Below this the water is acid; above, alkaline. Chemicals then are added to the aquarium water until it is of the desired acidity or alkalinity.

The dye most commonly used is bromthymol blue, best for fresh-water tests because it covers the scale from 6.0 to 7.6—yellowish green (acid), green (neutral), and blue (alkaline).

Phenol red covers the scale from 6.6 to 8.2—yellow (acid), orange red (neutral), red (alkaline), and therefore is better for a salt-water aquarium test.

There are a dozen others of too limited reaction to be of practical applicability to aquarium water conditions. Moreover, there are universal indicators which cover the range from 3.0 to 11.0, read by half degrees instead of by tenths.

One point commonly overlooked but important for the experimenter to remember is that pH 5.0 is ten times as acid as pH 6.0, and pH 9.0 is ten times as alkaline as pH 8.0.

933. How can acidity be rectified in fresh-water aquaria?

By placing a lump of plaster of Paris in the water and renewing it when it has been dissolved. (See also No. 119.)

934. How can alkalinity be overcome in fresh-water aquaria?

By the addition of acid sodium phosphate.

It was first overcome in The O'Brien Aquarium Tester with hydrochloric acid, but this disappeared overnight. Mr. Edward R. Hewitt suggested to Miss Mellen that phosphoric acid (acid sodium phosphate) would remain in solution and would not attack the glass as hydrochloric acid does. Experiments at the New York Aquarium proved this chemical excellent for the purpose. The results were published by Miss Mellen in *Aquatic Life*, September,

1928, and the LaMotte Company substituted acid sodium phosphate for hydrochloric acid in the O'Brien set. It has been used in all subsequent aquarium testing sets placed on the market.

935. How can acidity be overcome in salt-water aquaria?

By the addition of bicarbonate of soda. This was first suggested by Mr. Tilly, a Brooklyn chemist and toy fish enthusiast who gave the idea to Miss Mellen in 1928. Freshly stored sea water under the pH test is 8.2 (alkaline). Acids from the fishes bring it down to 7.0 (neutral), i.e., excess of carbon dioxide precipitates or renders more soluble the various salts in sea water. Bicarbonate of soda restores the alkalinity. Lime creates alkalinity, sea shells and tufa rock serving this purpose in public aquariums.

Increased aeration also is an important factor.

936. What is the pH of brackish water?

In the bromthymol blue test, brackish water of the North Atlantic Coast usually is 7.5 (verging between alkaline and neutral).

937. What is the pH of lake water?

This differs greatly according to locality. In a single inland state, as Dr. H. S. Davis reported of Vermont, it may vary from super-acid (4.0) to purely alkaline (8.0). In New York State, lake water may run to 7.8 or still more alkaline. In New England it may be neutral or slightly acid (6.2) where Trouts and Dace are living, and alkaline where the Black Bass abounds. (Bibliography No. 214.)

938. What is the correct pH for small fresh-water fishes?

Mr. W. G. O'Brien, who introduced pH to the amateur aquarist (and incidentally to the public aquarium) thought they do best at the beginning of the yellow tint under the bromthymol blue test—6.5, slightly acid. Wells found that fresh-water fishes select slight acidity in a gradient when the other choices are alkalinity and neutrality, and that they choose slightly alkaline water in preference to neutral. (Bibliography No. 150.) Yet some of the most successful aquarists keeping toy tropicals have found they do best in neutral water. The question is not easily answered since so wide a range of pH values exists in waters abounding with fish life.

Goldfishes adapted themselves to the brackish waters of Bermuda according to Goode (*Fishes of Bermuda*).

Some fishes (as the salt-water Killifishes) can withstand instant

transfer from strongly alkaline to superacid water (from pH 8.6 to pH 4.4).

Ocean fishes which seek fresh water to spawn adjust themselves readily to the change of pH, and the female Eel, after living for some years in fresh water, goes down to the depths of the saline sea to deposit her eggs; but, as is well known, Salmon play for some time in the brackish waters of estuaries before ascending the rivers, and the Eel passes through brackish water in her descent to the sea; that is, these fishes accustom themselves by degrees to the drastic change of medium.

939. Do agents other than the acids given off by the fishes alter the pH of the water in an aquarium?

Yes, plants, glass and decomposing food affect the pH, as well as acids given off by the fishes. Mr. E. R. Hewitt suggested that as soda glass makes the aquarium alkaline, the use of potash glass in manufacturing aquariums for fresh-water fishes might properly be substituted as it costs but little more and does not give off alkaline substances; but although this suggestion was published (*Aquatic Life*, September, 1928), we are not informed that any aquarium manufacturer has acted upon it.

940. In what amounts should acid sodium phosphate or bicarbonate of soda be used to correct acidity or alkalinity?

If any correction is to be made, the amount should be determined by the aquarium tester. Guessing is dangerous. Bicarbonate of soda if too strong will kill fishes in fresh water and can also be made too strong for salt-water fishes.

Chemicals should not be added directly to the water. They should be mixed first with water, fresh or salt, according to the water in the aquarium, and then distributed evenly over the surface, or added first to the water at one side of the tank and then to the other.

941. Are there ways of testing aquarium water for pH values other than by the use of dyes?

The "electrolytic method" is exceedingly accurate but involved. The dye method is simple enough for anybody to understand and therefore the method commonly employed, for even the most expert aquarists are not, as a rule, trained chemists.

DISEASES OF SMALL AQUARIUM FISHES

942. Are fishes an easy prey to illnesses?

Some are delicate, others very hardy, but all are subject to sickness the same as other animals. Improper food and contaminated water lower their resistance to disease, they are subject to contagion, preyed upon by parasites both internal and external, catch cold, suffer from indigestion, tumors, dropsy, malformations, et cetera. Introducing sick fishes into a tank of healthy fishes has caused the loss of countless valuable specimens.

943. Is it well to attempt to cure a sick fish?

This depends on how sick the fish is and how valuable it is. If the fish is in a dying condition, strong medicines will kill it instantly. If a fish is very sick but not dying, it can stand powerful doses, and, if the medicine is correct, will show improvement after the first treatment. Sick fishes should be removed to an aquarium by themselves and if possible not handled again until they are well. One of the secrets of successful fish therapy is to learn to recognize symptoms and act quickly. If no remedies avail and the fish is suffering, it is best to put it out of its misery. With large specimens this is done by a blow on the head. The city sewer is a convenient means of disposing of smaller ones.

944. What is the best sort of tank for a sick specimen?

A shaded tank with no boisterous companions, and live food to coax the appetite may save a weak specimen where handling and treating might prove fatal. Many fresh-water fishes are benefited by a mud bath, i. e., placing in a tank with earth on the bottom. This is a natural remedy which many aquatic animals seek in the wild state.

945. What is the best treatment for lacerations?

If permanganate of potassium in saturated solution is poured on lacerations while the gills are protected with a moist cloth, and the specimens then washed off in fresh water and returned to their aquarium, no infection will set in provided the treatment is given in time. Another effective solution used by Miss Mellen in the case

of torn scales consists in dropping the fishes into kerosene oil from one to three minutes according to individual resistance, following one week later with a bath in aluminum sulphate solution, one ounce to the gallon of water.

946. What is the cause of bloating in a fish?

Five troubles cause a fish to bloat—egg-binding, dropsy, gas, tumor (or rarely, cancer) and bacterial infection in the alimentary tract. If a fish, when tapped for dropsy, exudes no water, and does not respond to treatments for gas, egg-binding or bacterial infection, the case may be tumor.

947. Has cancer been found in small fishes?

Cancer has been definitely diagnosed in Goldfishes and toy tropicals, the same as in fishes of larger size. Tumors and even cancers sometimes disappear of their own accord. It is not possible to perform internal operations on a fish with certainty of success.

948. What should be done when a Sleeper (*Dormitator maculatus*) faints?

Sleepers should be kept in thickly planted tanks, fed regularly three times a week, and disturbed as little as possible until they become accustomed to captivity. If they faint, leave them to recover. Some observers think that only the male faints.

Fainting is caused by nervous shock due to fear of man and other disturbances of the nervous system.

949. In what way other than by fainting does nervous shock express itself in a fish?

In Goldfishes by exhaustion and debility, mostly in females chased too hard by the males prior to spawning; in Barbels by darting wildly about the tank, and in some other fishes by listlessness.

The best treatment is salt-water and mud baths, darkness, and a few days' abstinence from food.

950. How are symptoms of asphyxia recognized?

By inflamed gills (caused by poisonous gases or sudden changes of temperature), or gasping and distress (caused by prolonged absence of fresh oxygen). The fish may also exhibit a sore throat.

The best treatment for asphyxia is speedy elimination of the contributing factors. Use mechanical aeration if possible.

ABOUT YOUR AQUARIUM

951. What are the causes and symptoms of bacterial diseases?

They are due to overcrowding and polluted water and are evidenced by ulcers; also by yellowish areas with dark blue centers on fins and gills, spreading to the body and followed by *Saprolegnia*. Try the same remedy as for *Saprolegnia*. (No. 971.)

952. Do fishes have tuberculosis?

Yes. Goldfishes and other Carps suffer from tuberculosis and it occurs in salt-water fishes such as the Cod and Halibut.

The disease was identified as early as 1889 and has been worked with extensively abroad, also in the United States by Dr. Henry Winsor of Haverford, Pennsylvania, and Dr. Joseph D. Aronson of The Henry Phipps Institute, Philadelphia. *Bacillus tubercle piscium* is described in various papers in German and English. For tuberculosis in salt-water fishes Dr. Aronson proposed the name *Mycobacterium marinum*. He found the salt-water bacillus pathogenic for Goldfishes and frogs. (Bibliography No. 180.)

Tuberculosis has been found in gills, spleen, liver, kidneys, pericardium, intestines and eyes of various fishes; also in frogs and turtles. Fishes with tuberculosis generally are well preserved, fat, with full eyes and other outward appearances of health. Those studied by Drs. Winsor and Aronson were supplied through the courtesy of the Fairmount Park Aquarium in Philadelphia, where the symptoms before death were not observed. No remedy can be discovered for tuberculosis in fishes until the symptoms are known.

953. What can be done for general debility or "wasting disease" in a fish?

Transference to a tank of old green water with mud bottom is a standard remedy for fresh-water fishes. Feed live food, sour milk, chicken liver and egg yolk.

954. What is the remedy for a fish whose tail curves toward the head?

There is no remedy for this disease, which is caused by internal bacterial infection, either of the alimentary tract or the muscles. Prevention is our only hope. When the alimentary tract is clogged with bacteria, the fish begins to be listless and lies on the bottom. In a large tank of fishes, all usually face in the same direction. Then is the time to administer strong Epsom salt baths, for if the bacteria spread into the tissues and muscles, the case is hopeless. (See No. 987.)

955. What are the symptoms of tail rot, and the remedy therefor?

Blood streaks appear in the tail, a thin white line along the edges; the tail frays, becomes stringy, and rots.

Miss Mellen cured very severe cases by dipping the patient in turpentine from the gill back and then in 50% solution of peroxide, repeating in a week or 10 days if necessary. Mr. Lanier applies a 10% solution of argyrol with a soft cloth.

956. What are the symptoms of fin disease, its cause and cure?

Inflamed or disintegrated fins evidence the presence of this disease, which is due to contaminated water, overfeeding, or excitement.

Dr. Emmeline Moore has cured specimens of fin disease by placing them in a solution of permanganate of potassium, 1-50,000 for 10 or 15 minutes.

957. What is the remedy for bruises?

Deep bruises which sink into the tissues and muscles are fatal. For light bruises, Miss Mellen found kerosene oil and aluminum sulphate effective. Drop fishes in oil one to three minutes and one week later give a bath in a solution of aluminum sulphate, one ounce to the gallon of water.

958. What are the symptoms of colds in fishes, and the cure?

The symptoms of colds (known also as gill disease and gill congestion) are fading colors, sluggishness, milky areas on the scales suggesting an incipient attack of *Saprolegnia*, and refusal of food.

Dr. Moore found effective the same remedies she used for fin disease. Mr. Seale cured Top Minnows with a solution of mercuriochrome, 100 cc. of a 2% solution plus 50 gallons of water. Mr. Innes reported a cure for Goldfishes with salt baths, three and one-half ounces of salt to the gallon of water, placing the fish in the bath until it turns over, then transferring it to running water and repeating daily until improved. Miss Mellen cured South American fishes by placing them in a warm sea-water bath (80°), followed by warmer fresh water. The head was immersed twice, the body for fully five minutes. The sea bath was repeated in a week or 10 days if necessary.

Sometimes a large collection of fry in hatcheries develop colds due to a draft playing upon the surface of the water. Mr. Lanier has used successfully in such cases a bath in a pink solution of

permanganate of potassium, repeating daily until cured. (See No. 107.)

959. What is the best way to sterilize the aquarium after trouble with fish disease and parasites?

The fresh-water aquarium can be sterilized with a strong solution of ammonia, of salt or permanganate of potassium. The salt-water aquarium can be sterilized by scrubbing thoroughly with a soft brush dipped in tap water, then rinsed, then scrubbed again with the same brush dipped in a 5% solution of glacial acetic acid, after which it should be filled with tap water and allowed to stand for 24 hours. (Mix 49.5 parts 99% glacial acetic acid with 1,000 parts of water to produce a 5% solution.)

No fishes or plants should remain in a tank while sterilization is going on, and all traces of the chemical should be removed before they are replaced. Plants may be disinfected in a 4% solution of aluminum sulphate for 10 minutes on two successive days. (They will take new life after this treatment.)

960. What is the cause of dropsy in fishes, and its cure?

We do not know the cause. It is evidenced by scales standing out at an angle from the body because of water in the tissues, but although one suspects the disease may originate in the heart or liver, no exact knowledge exists on this subject. There are half a dozen causes of dropsy in human beings. There is localized dropsy, generalized dropsy, and dropsy of the serous cavities.

Several reports have been published of cures with quinine sulphate (which, to the medical profession, suggest that fish dropsy may consist of a bacterial infection of the liver, which would be reached by quinine sulphate). This drug has been administered in both weak and strong solutions, made up of four grams to the gallon of water for a 24 hour bath, or one gram to the gallon for a seven hour bath, then increased to three grams for 12 hours or 10 grams for three hours, when a cure is said to be effected with or without the coincident raising of the temperature.

Wolf discovered that tapping two or three times a year would keep dropsical specimens alive for several years.

Mark Samuel found that fishes could be made more comfortable by doses of digitalis, five to 10 drops to the gallon of water in a shallow aquarium; while Mr. Innes reported that starvation had effected improvement. Experimentation still is in order.

Dropsy, unless relieved, commonly proves fatal in about four months.

961. What is meant by tapping?

Tapping is effected by inserting a hypodermic needle on each side from below, upward and outward, just under the skin, thus extracting water from the tissues.

962. What are the symptoms of egg-binding, its cause and cure?

In most fishes the symptoms are loss of appetite, and, if far advanced, bloat due to gas from the decaying eggs. Egg-binding in tropicals is accompanied by listlessness but no loss of appetite. Some fishes die if not relieved.

The causes are pollution of the water and unnatural environment, particularly poor spawning conditions.

The only remedy for large sized fishes is one so old we do not know who invented it. Called stripping, it is used by all fish culturists, not only to relieve the fish of egg-binding, but to cause the ejection of eggs wanted for artificial fertilization. Stripping is effected by opening the vent with a small blunt instrument, which should be inserted parallel with the body. Gentle pressure then is applied from the pectoral fins toward the vent. This causes the eggs to flow out. If a forceps is used to open the vent, the eggs will flow out between the prongs. When rid of all the eggs, the fish will resume feeding; otherwise it may be necessary to strip again in a week or so.

For toy tropicals, a change to slightly cooler water has been found efficacious, also a change of location and placing ailing specimens with different males.

963. What can be done for injured eyes in fishes?

For fresh-water fishes, drop collyrium on the eyes three days in succession. This must be done gently while holding the fish with a wet rag bound around the gills. For salt-water fishes, use a 10% solution of silvol in precisely the same manner. (Silvol is a protein solution of nitrate of silver.)

964. What is the appearance of pop eye, or gas bubble disease, its cause and cure?

Bubbles form around the eye and then the eye protrudes if not taken care of. As a rule this condition is due to too sudden change of medium, as alteration in temperature, or too much compressed air in the water, resulting in the accumulation of gas bubbles in the blood stream, and these reach the fish's eye. It occurs in both fresh- and salt-water fishes, and has been likened to the human

malady known as caisson disease or bends, caused by rapidly passing between the compressed air in a caisson and the ordinary atmosphere, and, in divers, by being decompressed (brought up from the depths) too suddenly, and frequently resulting in vesicles of gas in the human blood stream.

If one feels expert enough to operate on a fish, the bubbles can be pierced with a needle. A milder remedy and a very old one is to transfer the fish to water containing more nitrogen.

A tank of old water with decaying vegetation and fish refuse is ideal for treating pop eye. Nitrogenous water can be produced quickly with ammonia, which, however, must be used cautiously. Great experts have succeeded with one-quarter teaspoon in 15 gallons of water, keeping the affected specimen in the solution for three hours or longer, according to its reactions, then transferring it to a solution half this strength, and so on until it can be returned to an aquarium containing no ammonia.

965. What is a fluke and how can its presence be recognized?

A fluke is a parasitic trematode worm having a flattened, leaf-like body provided with suckers, usually two. Flukes are found on the gills and bodies of fishes. The generic name of the common fresh-water fluke is *Gyrodactylus* (the disease being known as *Gyrodactyliasis*). The fluke bears living young which before birth contain the young of the third and fourth generations.

Diseased fins, sometimes ulcerated and broken, ulcers and other inflamed spots on the body, also loss of appetite, result from the presence of flukes.

966. How can flukes be destroyed on fresh-water fishes?

Dr. G. C. Embury of Cornell University, who experimented with Goldfishes and live-bearers, reported an almost 100% control by immersing the specimens in a solution of acetic acid. For fishes under two inches, he used a .1% solution, for larger specimens, .2%, immersing the patients with a net for one-half to one minute.

(One part 99% glacial acetic acid plus 495 parts of water produce a .2% solution.)

Dr. R. V. Bangham of Wooster College, Wooster, Ohio, killed these parasites by immersing the fishes (in this case Goldfishes, Bluegill Sunfishes and Catfishes) in a solution of glacial acetic acid, one part to 500 parts of water, for from 40 to 60 seconds. (See also No. 968.)

1001 QUESTIONS ANSWERED

967. How can flukes be destroyed on salt-water fishes?

In salt-water fishes they attach themselves to the eyes as well as other parts of the body. They can be destroyed with a 10% solution of silyol (not argyrol). Immerse the entire fish for from one to three minutes. The flukes appear to be able to retain water in their suckers, which makes them more resistant to chemicals, for off the fish they die in 15 seconds. On the fish, it takes longer to kill them.

968. What is a leech, and how can it be eradicated?

A leech belongs in the group of annelids or ringed worms (the same as an earthworm). It has an oral sucker around the mouth for drawing the blood of its host, and another rear sucker. Most leeches inhabit fresh water and many are parasitic on fishes and other aquatic animals.

Try the same remedy as for flukes. Leeches and flukes settle among plants and are difficult to see. The tank should be sterilized and plants destroyed.

969. What are the symptoms of indigestion (also constipation) in fishes, and the remedy therefor?

The abdomen swells, specimens become sluggish and stand on their heads or lie listlessly on the bottom of the tank.

The oldest remedy is to hold the fish upright in a wet rag and drop castor oil down the throat with a medicine dropper. Miss Mellen found that small fishes could be immersed for one or two minutes, according to size and resistance, in a cup or bowl of castor oil, and then removed to another bowl containing water of the same temperature as that in the aquarium, until the oil has risen from the body. Drain off the oil and return the fish to the aquarium. Food should be omitted for one week, after which cooked cereals, custard, junket, and boiled spinach may be given. Fishes not too far gone respond immediately to this treatment and the effect of the oil is apparent in the excreta for several days.

Wolf observed that fresh earthworms are a laxative desirable in such cases.

If grains of Epsom salt are dropped in the water, fishes often will pick them up; or a mild Epsom salt bath may be given. (See No. 987.)

970. What disease causes white spots on the fish?

There are two diseases which cause white spots, the more common being due to a plant which has lost its chlorophyll—*Saprolegnia ferax*, called also white fungus, and white mold. If the fish becomes bruised or its slime rubbed off, spores of *Saprolegnia*, which are constantly being cast about in the water, are almost certain to attach themselves to the affected spot. *Saprolegnia* has the appearance of tiny tufts of white cotton, which distinguish it from the other disease causing white spots and known as White Spot Disease or Itch, which is characterized by white pits in which the parasites are lodged. (See The Itch, Nos. 983-985.)

971. What is the best remedy for *Saprolegnia* disease?

Like most other plant life, *Saprolegnia* develops rapidly in bright light and can be killed by placing it in the dark.

Fishes such as Goldfishes of garden pool size may be immersed in kerosene oil for two minutes, then placed in fresh water of the temperature of the pool water, until the oil rises to the surface. The oil then may be drained off and the fishes replaced in the pool.

A remedy commonly applied and frequently efficacious is the salt bath. Prepare by using common table salt with water, beginning with a weak solution of one tablespoon to the gallon and immersing the fish for half an hour. Repeat this every day if the specimen appears benefited, or make a stronger solution for a shorter bath if the condition of the fish indicates the need for more drastic treatment. Another old remedy is immersion in a rich pink (not red) solution of permanganate of potassium, using two grains by weight to the gallon of water for a 10 minute bath. Or a 2% solution of mercurochrome may be applied directly to the affected spot.

972. What is a saturated solution?

A solution prepared by adding just enough water to a chemical to dissolve it.

973. How can one treat skin diseases evidenced by a spreading inflammation of the skin?

Painting an infected spot with a saturated solution of permanganate of potassium will generally effect a cure. If not, dip the fish in turpentine from the gills backward, then in 50% peroxide. Care must be taken to keep these away from the eyes and gills. This treatment followed by a mud bath is excellent.

974. What is the trouble with a fish that floats and appears unable to descend?

This symptom, rarely noticed in pigmy fishes but occurring in Goldfishes and salt-water species, may be due to some unnatural condition in the environment, as density of the water, or to gas caused by improper food. Sometimes the fish stands on its head and floats, alternately. It is well to try first the remedy for swim bladder trouble and if this is not successful then resort to the more drastic remedy for gas.

For fishes that float and have also swollen bodies, Mr. Lanier uses a solution of equal parts of Epsom and rock salt, four table-spoons to each gallon of water, allowing the patient to remain in the solution for four hours or longer. Maintain an even temperature, do not overcrowd, and give live food if possible.

975. Is there any remedy for gas?

A general remedy, successful in many cases, is effected by piercing with a strong needle. The left pectoral fin is turned forward and the needle introduced behind it in a backward, upward direction.

976. What is the remedy for swim bladder trouble?

Add to every 15 gallons of water one teaspoon of acid sodium phosphate and one-fourth teaspoon of household ammonia. Generally this treatment will effect a cure in a few hours. Add the two chemicals to the aquarium if the pH test indicates a need for correction.

977. What remedy is there for spinal curvature?

This occurs sometimes in old toy fishes, and is not to be treated; but if curvature occurs in young specimens, the trouble is due to rickets. In this case, butter has been used, fed in a separate container. Grated cuttle bone and ground fish bone can be mixed with the food to provide lime.

978. What is the cure for a fish that "shimmeys"?

Shimney is a name given to a fish which acts like a person dancing a "*shimmy*," i. e., making a shivering motion. It probably is due (in the fish) to dizziness or a kind of palsy which accompanies one of the wasting diseases sometimes mistaken for tuberculosis. Also, it may be caused by chilling.

Mr. Lanier places the patient in an aquarium with old green water and garden soil. Usually a cure is effected in five weeks. In the

meantime the aquarium it occupied is thoroughly cleaned and reset, and the fish, on being returned, is provided with more aeration.

We know that "shimmeying" is not tuberculosis, because fishes with tuberculosis do not "shimney."

979. What is the cause of pigmouth in little fishes?

This apparently is due to absence of sand. Specimens afflicted with the disease, when transferred to an aquarium containing fine sand, will seek the sand immediately and frequently, with beneficial results.

980. What are the symptoms of black fungus disease and its cure?

Black spots appear on scales and gill covers, with or without inflammation. This disease, common in Goldfishes and other fresh-water fishes of the temperate zone, formerly was believed to be parasitic in origin. Miss Mellen found no parasites under the microscope and believes the condition due to a disturbance of pigmentation caused by general debility or blood disorder. She cured 90% of cases with strong salt solution, submerging the fishes as long as they could stand it and then transferring them to a mud bath for a week.

DISEASES CAUSED BY PROTOZOAN PARASITES

981. From what protozoan parasitic diseases do small aquarium fishes suffer?

Several parasitic protozoans infest aquarium fishes, including three which produce Slime Disease: *Chilodon cyprini* (the species which attacks Goldfishes, Catfishes, Sunfishes and others), *Costia necatrix* and *Chylochoëta domerguei*. Another is the well known *Ichthyophthirius multifiliis*, causing the disease called Itch (properly Ichthyophthiriasis).

982. What are the general symptoms of fishes affected with Slime Disease and the remedy therefor?

The parasites cause the fishes to become covered with mucus, sluggish and without appetite. Sometimes the victims develop a coating of blue white slime, or regular, opaque spots form, unite, and encase the body with a mucus coating in which the parasites are embedded. The scales drop off, and when the gills are attacked the fishes suffocate.

Miss Mellen treated a collection of large Comet Goldfishes infected with Slime Disease by immersing them for three minutes in kerosene oil, then transferring them to a mild salt bath renewed each day for 10 days, when they were returned to exhibition in good health and color.

983. What are the symptoms of Itch or White Spot Disease?

The body becomes dotted with white specks, really pits which the protozoan parasites create by eating through the scale pigment. They soon occupy every scale and inflammation follows, *Saprolegnia* taking root in the infected areas. Gills and mouth may also be affected. Fishes become slimy, quiet and depressed, brush themselves against the sides and bottom of the tank (hence the name of "Itch" given the disease), refuse food, and die in a few weeks unless relieved. Toy tropicals are more subject to this disease than to any other, the parasites appearing to be always with them, awaiting favorable conditions under which to multiply. Tropical fishes develop the Itch when subjected to crowded conditions and rapid fluctuations in water temperature; also the absence of running water, this disease occurring in nature during the dry season, when tropical streams shrink to a series of disjoined pools and there is no flowing water to carry off the parasites.

984. What is the best remedy for White Spot Disease or Itch?

Running water in an undercurrent is the best remedy, but this cannot be supplied in heated aquaria. Many remedies have been tried—salt, mercurochrome, baking soda, raising the temperature of the aquarium, et cetera, and some of these are successful if used in the early stages of the disease.

Mr. Lanier has succeeded in eradicating slight infestations by raising the temperature to 85° or 90° for three hours or longer, allowing this to cool slowly to 80° and keeping it at this temperature for one day. By repeating daily, he found that on the fifth day the parasites were dead and only four fishes out of 17 were lost. He has also succeeded in eliminating the disease in its incipient form in five days by heating the water to 80° and adding one-half grain of permanganate of potassium by weight to the gallon of water.

Mr. Wallace Adams first effected a cure with mercurochrome, by using five drops of a 2% solution to the gallon of water for five days, renewing each day. Others have succeeded with the disease in its early stages by heating the water to 80°, adding four drops of a 2% solu-

tion of mercurochrome to each gallon, and leaving the patients in this solution for a week.

If the disease is well advanced, it usually is necessary to fall back on the bothersome but certain remedy of having two sterilized jars and changing the fishes from one to the other twice every 24 hours for a period of five to 10 days, using water of the same temperature as that in the aquarium or raising it to 88° and placing lump or rock salt on the bottom. Meantime the aquarium should be left without fishes for 10 days.

985. How do the Ich parasites multiply?

When the young parasite which is embedded in the skin of the fish leaves the host, which it does in from two to five days, it drops to the bottom and there forms a cyst (hence the placing of salt on the bottom of the tank). Spores break out of the cyst in from one to three days and seek a host. The parasites also reproduce by simple division while swimming around. Changing the water therefore kills those which have left the fish, since they cannot be killed while on the fish. These parasites multiply more quickly in warm water (hence the practise of raising the temperature).

986. What can be done for a fish that swims with jerky movements, then sinks to the bottom?

No cure has been discovered for this condition, which is believed to be due to a collapsed air bladder.

987. What is the right way to give a fish a salt bath (with table, rock, lump or Epsom salt)?

The strength of the solution and the duration of the bath depend upon the condition of the fish. A very sick fish will need a stronger solution and a longer immersion than one not so sick. For a *weak bath*, use one teaspoon of salt to the gallon of water and leave the fish in the bath for 24 hours. When further treatment seems to be in order, change the solution and give another 24 hour bath, but be careful to have the fresh bath of the same temperature as that from which the fish is transferred. Move the fish in a spoon or cup if possible, to avoid damage by nets.

For a *strong bath*, use one tablespoon of salt to the gallon of water for 15 to 30 minutes. For severe cases try stronger solutions. A fish which appeared to be dying was placed in a basin with less

than a quart of water and a handful (over two ounces) of salt for a few minutes and recovered completely, living for a long time afterward. Judgment must be used and will come easy when one has learned to observe his fishes and know by their actions when they need attention.

Salt baths agree with the majority of fresh-water fishes, but dwarf catfishes cannot endure them.

THE GARDEN POOL

CONSTRUCTION

988. What materials are needed in the construction of a garden pool?

Garden pools may be constructed of clay, cement concrete, stone, tiles, or tar paper and asphalt.

989. What is a desirable depth for the garden pool?

Regardless of other dimensions, the pool should be built from eight to 12 inches below the depth at which ice is likely to form, i. e., in some localities a very shallow pool may serve, while in others it should be at least two feet deep.

990. How can one construct a clay pond for keeping water lilies and a few Goldfishes?

The pond should be excavated to a depth of 24 to 30 inches. Place clay on sides and bottom about four or five inches thick. This should be well puddled so that no opening remains for the water to seep through. If the clay is too hard, it can be made soft and plastic by sprinkling water over it, after which it is easily pressed into place.

Earth six or eight inches deep should be laid in the finished pool for water lilies and other plants.

991. What is the difference between a formal and an informal pool?

Formal pools are of various geometrical shapes—round, rectangular, square, and so forth. Informal pools are irregularly shaped, fitting into the natural background. Either type can be arranged very attractively. (Bibliography No. 230.)

992. How can one build a cement concrete informal pool?

Without forms or reinforcing:

If the soil is firm, excavate carefully only the width of the walls and use this trench for your form. After the walls have been concreted and have set, dig out the interior and pour the bottom, taking care to seal the joints between the bottom and sides by using a pure

cement mixture and brushing this thoroughly over them.

Without forms and with reinforcing:

An informal pool with sloping sides is easily built in any size without forms. When a place has been decided upon, hollow out to the desired shape. The sides should be sloped to an angle of 35 to 45 degrees and the soft spots on sides and bottom filled in to render them solid and firm.

Use either one-quarter to three-eighth inch steel reinforcing rods, laying them in 12 inch squares on the bottom and sides, or fence wire



Informal Garden Pool

Large stones have been cemented into place to form this irregular pool, so natural in effect. (It is the property of Mr. and Mrs. C. H. von Staden, San Anselmo, California.)

of No. 8 gauge with mesh not over eight inches each way. When fence wire is used, overlap at least six inches at the joints. When the concrete has been poured into place, raise the reinforcing wire slightly until it is embedded just within the concrete. Walls should be not less than four inches thick for pools 5' x 10' and 24" deep. When pools are 10' x 20' and 36" deep, the walls should be six inches thick, the bottom seven inches, and reinforcing should be with one-half inch rods. Thicker or thinner walls can be used, depending upon the condition of the soil. With solid soils, thinner walls will serve. With movable soils of sand, clay or quicksand, heavier walls are necessary.

If an overflow is desired, arrangements should be made for it before the concrete is poured into place. Let concrete set for about two days, keeping it covered with old wet burlap sacks to prevent

rapid drying out. After second day apply a coat of waterproof cement and water mixed to the consistency of cream. This coat can be applied with a stiff brush and will waterproof the sides and bottom. Before fishes are introduced, the pool must be seasoned. (See No. 995.)

With forms:

Where forms are used, these commonly are of wood and should be wetted before pouring the concrete. Steel and galvanized iron sheeting also are used. They must be reenforced with wood when not firm. When metal forms are used, wipe the surface with oil or grease.

The concrete:

If possible, the whole work of concreting should be completed at one operation to render the bottom and walls completely homogeneous.

Where forms are used, the concrete should be of a creamy consistency that will pour easily.

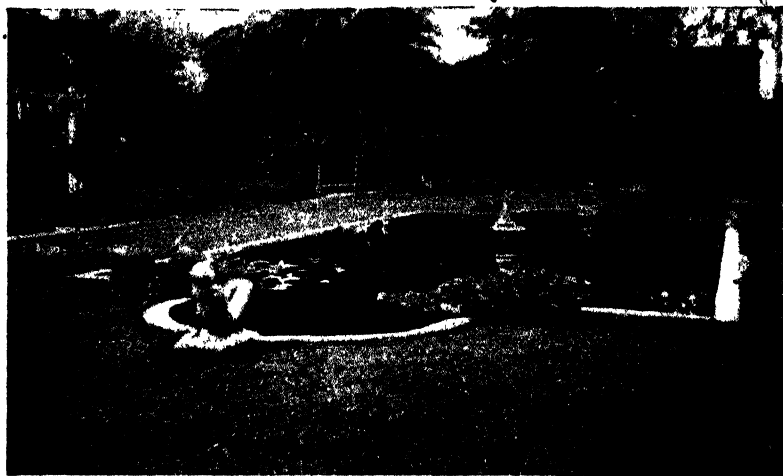
For sloping sides and where no forms are used, the concrete should be made pliable and not too wet, so that it can be troweled on and easily molded to any shape without running.

993. How can a crack be repaired in a garden pool?

If the pool is reenforced, the crack may easily be repaired by thoroughly cleaning and drying the crack and pouring in melted roofing tar. Another method is to chip away all loose concrete in the crack, dampen with water, then tamp in a mixture that is not too soft, consisting of one part cement to two parts of fine sand. Before this has dried, paint over with a waterproof cement and water paste.

994. How can one construct a formal cement concrete pool?

Of the many types of formal pools, those of rectangular shape are most popular. Some are made with sloping sides, but most are straight-sided and usually the same depth throughout. In firm ground, it sometimes is possible to dig to the required depth and have the outside of the excavation act as the outside form. But if this is not possible, it will be necessary to dig to the required depth and size of the pool, allowing room for the forms; then construction of forms will be needed for the side walls, both inside and out. The inside form should be six inches shorter at the bottom than the outside form, so that when the concrete is poured it will spread beyond the inside wall and make a better joint with the bottom and sides. Reenforcing rods one-fourth to three-eighths inch in diameter should be used; or fence wire of No. 8 gauge with about four inch mesh, placed in the center of the concrete when poured, will help to prevent the pool from cracking. If possible, try to pour the whole pool in one operation.



A Formal Pool of Cement Concrete

Designed and constructed by Arthur B. Hyde for the grounds of Mr. E. J. McCutcheon, Palo Alto, California.

When a drain is put in, slope the bottom toward the drain and use one and one-half inch galvanized pipe or larger for the outlet; also provide a galvanized coupling, which should be set flush with the bottom of the pool. This coupling, which is sometimes made of brass, will hold the standpipe in position and it can be removed easily when the pool is to be lowered. If at any time one wishes to reduce the depth of water in the pool, a shorter standpipe can be used.

The top of the pool may be finished in the form of coping, brick or stones, added after the pool is completed.

995. How can a concrete garden pool be "cured" or seasoned?

It can be seasoned by being allowed to stand for a period of three weeks or a month, with frequent changes of water, or by washing the sides with vinegar or a dilute acid solution to remove soluble materials from the concrete which may be detrimental to the fishes.

Mr. W. G. O'Brien recommended adding sulphuric acid, which, when mixed with the free lime that has leached from the concrete, forms plaster of Paris.

The following, used by a Nevada pool owner, is said to be an excellent way of seasoning; one which quickly neutralizes the lime and penetrates the concrete:

Use one pound of alum to every 20-gallons of water, dissolving it thoroughly and allowing it to remain in the pool for eight days. Then empty and clean the pool well. Refill with water only and allow to stand three or four days. Empty again and leave without water for 24 hours. After this the pool is ready to fill with water and stock with plants and fishes.

996. Will a concrete pool with straight (perpendicular) sides crack during zero weather?

Yes, especially where a poor concrete mixture has been used, or where reinforced steel is omitted in the construction and the sides are not sufficiently heavy. When water freezes, as we all know, it expands, exerting a horizontal pressure on upright sides; therefore, sloping sides in a pool tend to deflect the ice upward, increasing its resistance against cracking. But, while sloping sides have proved preventatives against winter cracking, well made perpendicular sides, sufficiently heavy and properly reinforced with wire or steel, are not commonly affected by zero weather.

997. How can one construct a garden pool of stone?

Only hard stone is suitable. To construct a garden pool of stone and have it leak proof, it is necessary to have a skilled mason do the work unless the person who contemplates building the pool is a good cement worker. Stone pools seldom are constructed because they entail too much time and labor and the cost usually is too great. In many cases after a concrete pool is built, rock work is arranged in it to suit the fancy of the owner, and this takes the place of the stone pool.

998. How can one make a garden pool of tiles?

A tile pool requires a concrete foundation. Many pools have been built of colored tiles, such as white or green, black or gray. Like the stone pool, it requires a skilled mechanic to construct a satisfactory tile pool, and the cost is more than many can consider.

999. Is it necessary to provide a sewer drain for a garden pool?

No, but a drain often is installed in a large pool and when a standpipe also is installed, proves convenient for lowering the pool to the depth desired. When the pool is not provided with a drain, it is necessary either to bail out the water with a bucket, pump it out, or use a rubber siphon when emptying it.

1000. How can one siphon the water out of a garden pool?

Attach the garden hose to the faucet and fill it with water. Place the open end in the pool and detach it from the faucet. Now take the detached end to some point below the pool's level and release the water in the hose. It will siphon out the water from the pool.

The siphon may also be started by placing one end of the hose in the pool and then taking the other end below the pool's level. By sucking hard at this end a vacuum is created in the hose and the water will begin to flow out, thus siphoning out the pool.

1001. How can one drain a garden pool without having the fishes go through when the standpipe is removed?

Use a strainer. A square strainer made of one-quarter-inch mesh galvanized wire, fastened to a pole, may be placed over the outlet as soon as the standpipe is removed.

A roof strainer made of heavy galvanized wire, bell-shaped and of one-half inch mesh, fastened to a pole, may also be used.

1002. Are metals dangerous to fishes in a garden pool?

Standpipes of brass, where the water is overflowing to waste, are not necessarily detrimental; but where the water is used over and over, brass should not be used unless painted with black asphaltum varnish.

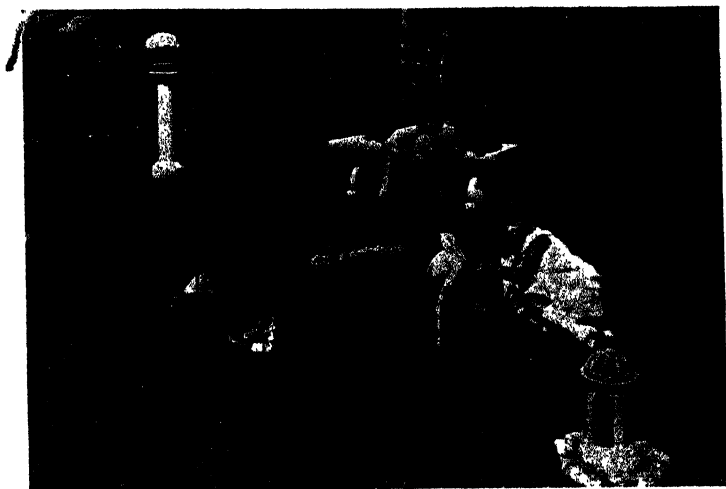
Galvanized pipe or shipping cans, when thoroughly cleaned and painted with black asphaltum varnish, will be safe for fishes.

Copper should be avoided in both pools and tanks containing fishes.

1003. How can a garden pool be constructed with tar paper and asphalt?

The following instructions for the making of a tar paper and asphalt garden pool are given by Mr. Charles J. Weidel of Rochester, N. Y., who invented this method:

Excavate the pool in the spot selected, and save the earth taken out for use in building up around the edge. This makes it easier to gain the desired depth—say 20 inches in the deepest part. Have one area (about three feet) several inches deeper. Here the fishes may take shelter when for any reason it becomes necessary to empty the pool. Rain water draining into the pool will make it muddy. To avoid this, the earth should be sloped away from the pool. If a border of earth is built around the pool, a rock garden may be established in it,



Photograph by Charles J. Weidel

rowing his attractive garden pool in Rochester, N. Y., lined with melted asphalt over roofing paper.



Photograph by Charles J. Weidel

The same pool eight years later, now widened and illuminated by flood light to extend the enjoyment of its beauty after sunset.

greatly beautifying the spot. Irises do exceptionally well in such locations.

In digging the pool, care should be taken to slope all sides gradually and regularly. One edge should be lower than the remainder to permit the overflow to escape gently. The sides should be smooth, with no roots or stones projecting. These will puncture the lining and create a leak.

The pool should be lined with strips of roofing paper of a smooth, pliable grade. Slit the edges of the paper strips deep enough to cause them to lie perfectly smooth against the sides of the pool. On the curves it will be necessary to use narrower strips (12 to 15 inches wide), slitting them three or four inches deep every four or five inches on both sides.

When the entire pool has been lined with the first layer of paper, make ready another similar layer to lap the joints of the first layer. Swab the first layer of paper, a small area at a time, with hot melted roofing asphalt and apply the second layer piece by piece. To this add a third layer, then give another coat of the melted asphalt.

It will look shiny black when finished, but within a week or two will assume a very natural appearance.

It is necessary to use roofing asphalt of the kind that requires melting. This sets quickly and remains in place. Pitch and ready mixed liquid asphalt are not desirable for this purpose.

A flexible pool of the kind here described is impervious to frost and lasts for many years.

All plants should be rooted in boxes or pots, as some, especially cattails, force their roots through the seams, causing leaks. If the water is siphoned off or bailed out in the fall, when the fishes are taken indoors for the winter, hardy lilies and other plants may be covered with leaves a foot deep, then with boards, and on top of these more leaves; and with this protection they will winter even though the thermometer drops to 32° below zero.*

1004. What construction is most satisfactory for a garden pool?

That depends on the taste of the builder. Concrete, clay, stone and tiles make geometrical and beautiful pools, though very special care is needed to prevent cracking by frost in states where frost occurs. The tar paper and asphalt pool, while certain to withstand freezing, must be safeguarded while being constructed and planted, against leaks caused by stones and old roots, and roots of plants introduced.

* All temperatures are Fahrenheit.

1005. How should water be supplied for the garden pool?

Water may be supplied from the garden hose when necessary, or a three-quarter inch or larger galvanized iron supply pipe may be installed at one end of the pool (always at the end opposite the overflow, if one is put in).

1006. Is it necessary to have the water running continuously in a pool which contains Goldfishes?

No, provided they are not too crowded. However, the supply of water should be close at hand so it can be added to make up for evaporation or leakage. Where many fishes are kept, running water can be supplied by using an air pump or a circulating water pump. Many attractive pools are arranged with a waterfall that provides very pleasing effects and uses the same water over and over. Pump manufacturers will gladly supply the proper pump when the capacity of the pool and the volume of water which it is desired to circulate are explained.

1007. What is the best location for a pond or large pool in which water lilies and fishes are to be kept?

If tender plants are to be used in the pool, the location should be a sheltered one, with trees and shrubs planted near. The trees should not overshadow the pool and prevent the sun's rays from warming it, for these are beneficial to both plants and fishes.

1008. Do leaves from trees and shrubs render the water of the pool injurious to the fishes?

Yes, if large quantities are allowed to accumulate for two years or longer they will cloud the water and render it foul. See next question.

1009. How often should the pool be cleaned?

In most states once a year, unless the water becomes foul. Many pools are cleaned each spring when the water lilies are divided and replanted. Undesirable fishes then are removed and desirable ones retained. Where the water is very hard, the presence of a small quantity of leaves may prove beneficial.

1010. How can one construct a garden pool for tropical fishes?

In the same way as for any other fishes. A single coil of one and one-quarter inch galvanized pipe placed around the bottom of the pool will maintain a proper temperature. Circulating hot water or steam can be used for heating the pool.

PLANTS

1011. When is the best time to start a water garden and plant water lilies?

About the latter part of May is a good time for the hardy varieties.

1012. Can tropical lilies be kept with the hardy varieties in the same pool?

Yes, select the warmest location in the pool, where the sun will surely strike them.

1013. Which plants are best for the garden pool?

Water lilies (*Nelumbos* and *Nymphæas*) hold first place for small and large pools. After these, for the small pool, water hyacinths, umbrella plants, common dock, sweet flag, water poppy, Egyptian papyrus, and some of the aquarium plants—giant *Sagittaria*, *Cabomba*, Chilean *Myriophyllum* or Parrot's Feather, Water Ferns and Water Lettuce. (The last two are not hardy in the north.)

Water-cress may be transplanted from the wild brooks and will bloom in June and July in shallow water.

Azolla, *Salvinia* and Duckweed furnish an excellent shade in small pools but should not be allowed to cover the entire surface or interfere with the growth of larger plants.

Madagascar lace plant is very decorative for a small pool.

The pink lotus of India thrives in small quarters but most other lotuses of East and West are suitable only for large pools, their bulbs extending three feet into the mud of a pond, making them difficult to remove if one wishes to replace them with other kinds of vegetation; but they do well if planted in wooden or stone containers. Lotuses are very ornamental and provide a favorite shade for fishes, but cannot withstand a cold climate unless protected. Giant water lilies—*Victoria regia* and *V. cruziana*, also are suitable only for large pools and require careful protection against freezing.

Bulrushes and cattails also are for large pools, soon overrunning their quarters if not restricted.

(Bibliography, Nos. 106, 108 and 115.)

1014. How many plants should be introduced into the pool?

Enough to cover three-fourths of the water surface. This is the best protection against the formation of algae and scum.

1015. What is the best way to introduce plants into the pool?

All large plants and those with deep roots should be planted in tubs of earth 18 inches square and one foot deep, packing earth around the roots and covering it with sand and pebbles to a depth of one and one-half inches. The best mixture for water lilies is one part well rotted cow manure and about four parts good garden soil. There should be 10 inches, preferably 18 inches of water above the pebbles or gravel. Lilies usually do best if started in shallow water (three to six inches deep) until they begin to leaf.

Lily boxes should be from two to five feet apart.

For very large pools, the length of plant containers may be doubled. For small plants in shallow water, the boxes need be only 12 inches square and eight inches deep.

1016. Should tubs or boxes for plants in pools be of wood or concrete?

Wood containers are more easily moved and are preferred by many people for this reason, but for the large pool, concrete boxes are best. If wood is used, select cypress or white cedar of seven-eighths inch stock.

1017. How can one break up the plain borders of a garden pool?

By arranging stones of different sizes and shapes around the pool and establishing plants among them.

1018. Which are the best plants for the margins of the pool?

For tall plants hardy phlox and azaleas may be used. Japanese iris likes moist places (but not German iris), ferns always are suitable, and marsh marigolds can be collected from the borders of brooks. Forget-me-nots do well, also rock plants such as creeping phlox, rock cresses (*Arabis*), plants of the genus *Sempervivum*, including the house leek and the well known hen-and-chickens (of which there are more than 30 species).

1019. How can algæ and scum be destroyed in a garden pool?

This depends on the size of the pool. In a small pool, algæ can be destroyed by covering the pool with planks for a few days. This does the fishes no harm and the algæ die off for want of sunlight. If feasible to introduce *Daphnia*, they will eat all the algæ within a few days.

In the larger pool, copper sulphate commonly is employed for the destruction of microscopic plants and animals but may prove a

dangerous resource unless the reactions of fishes and algae to this chemical are understood. Some algae are killed in a solution of one part copper sulphate to 12,600,000 parts of water, though other species succumb only in a much stronger solution—one part copper sulphate to 20,000 parts of water. The Water Department of the City of New York uses only one part copper sulphate in two million parts of water. Goldfishes and Minnows can resist a solution of one part copper sulphate to 200,000 parts of water, while other Carps, also Catfishes, die in a solution of one part to 500,000 parts of water.

The safest, simplest method of introducing copper sulphate is to swish it around in a bag for a short time and repeat the operation three days later if necessary. Tie one-half pound of the chemical in a fine-mesh burlap sack which prevents the crystals from falling through. By this means, no injury to the fishes should result.

1020. How often should new soil be given water lilies?

For good results they should not be allowed to go over three years without new soil, and replacing every two years is better. Each year, hardy water lilies should be given new manure or some good fertilizer.

For the sake of the fishes, care must be taken not to overdo this and to cover well with pebbles.

FROGS AND TURTLES

1021. Are frogs and turtles desirable in the garden pool?

That depends on the size of the pool. All natural ponds contain frogs and turtles, but in a very small pool they might prove inimical to the fishes. The same applies to water snakes and crayfishes, the latter being destructive also to clay pools. We therefore recommend the omission of frogs, turtles, water snakes and crayfishes from the garden pool.

FISHES

1022. How long should a new concrete pool stand before fishes are introduced?

Generally from four to six weeks, and the water should be changed at least five times during this period. All new concrete or wooden tanks should be well seasoned before any animal or plant life is introduced.

1023. How many Goldfishes should be introduced into the garden pool?

Eight fishes—about four or five inches long, to every 50 gallons.

1024. How should fishes be introduced into a garden pool?

Fishes should be quarantined for about two weeks before introduction into the garden pool and watched for the presence of such parasites as *Argulus* and *Lernæa*. If found, these should be removed with tweezers and the fishes sterilized in a mild salt bath; or if touched with a swab as described in No. 1030, the solution will kill the parasites and sterilize the wound as well. When fishes are ready for introduction into the pool, transfer some water, a little at a time, from the pool into the receptacle in which the fishes are held. This accustoms them to the temperature and mineral content of the water in which they are to live, and will prevent the loss of valuable specimens.

When the fishes are in good condition, introduce them into the pond by allowing them to swim out of their container—not by dropping them into the water.

1025. Which of the toy tropicals can be kept in an outdoor pool?

Paradise Fishes, Rosy Barbs, Mollies and many others where the climate is not too cold. Many toy tropicals are kept in pools during the summer in the eastern states, and sometimes large families surprise the owner when he takes his collection indoors for the winter.

1026. From what diseases and parasites do fishes suffer in garden pools?

Saprolegnia or fungus disease, the anchor parasite (*Lernæa*) and various species of *Argulus*, the so-called "fish lice," are the commonest pests in garden pools. The toy tropical is a prey to the Itch anywhere and everywhere. In a neglected pool, fishes may die from blister disease.

1027. How can *Saprolegnia* or fungus disease be treated in a garden pool?

Shut off the water and introduce one scant teaspoon of permanganate of potassium to each 40 gallons of water. Lower the pool to about 18 inches and allow the fishes to remain in the solution 15 minutes. Then allow running water to carry it off. Repeat every day

until the fishes are cured. The chemical should be mixed with water first and distributed as evenly as possible.

1028. What is a "fish louse" and how does it injure the fish?

A "fish louse" is not a louse but a copepod crustacean belonging in the same order of animals as the Cyclops. The scientific name of the parasite is *Argulus*, commonly referred to as an argulid. There are various species. Each species of *Argulus* has its own special hosts. Mr. Walter H. Chute has observed that the argulids which infest the Gars will not attack other fresh-water fishes left in the tank after removal of the Gars, but die apparently from lack of proper hosts.

The "carp louse," commonly found on the Goldfish, may have other hosts as well.



An argulid, common pest of garden pool fishes. This species (*Argulus trilineatus*) is found on Goldfishes. (After Guberlet.)

The argulid thrusts its head under the scales, inserts a needlelike piercing organ which in some species is connected with a pair of poison glands, and then sucks the blood. Young argulids leave the host only to undergo metamorphosis. Mature argulids leave the host to spawn in spring and autumn. The females attach themselves by their two round suckers to stones, plants, or the side of the tank or pool, and deposit their eggs. In public aquariums the eggs may be seen on the glass of the tank in even strings like miniature trains of cars. They are white or yellow, oval in shape, and enclosed in a gelatinous covering. They hatch, according to species and temperature, in two weeks or not for seven months, and the young seek a host immediately. Their life span is something more than six months. (Bibliography No. 89.)

1029. Do any fishes eat argulids?

The Common Roach, Sunfishes, Dace, and some of the Cichlids have been observed to eat them when the argulids are in the young stage.

1030. How can argulids be eliminated from a garden pool?

One method is to hold the fish in a wet rag and pull the pests off with tweezers, sterilizing the patient afterward in a mild salt bath; or touch the parasites with a swab dipped in turpentine, iodine, kerosene, or a saturated solution of permanganate of potassium, which causes them to drop off.

In some cases the parasites have been eliminated by removing the Goldfishes from the pool, ridding them of their parasites and leaving the pool without any fishes for a month. Adult argulids remaining in the pool and their young which hatch starve without a host. Of course this does not apply to species of argulids the eggs of which do not hatch for more than one month.

As far as we know, argulids seldom have been killed while on the fish. Miss Mellen destroyed the pests while on the fish by the use of a mercurochrome solution in which the patient was immersed for five hours, and Mr. Walter H. Chute uses chloroform, but these remedies are not advised for fishes of home aquarium and garden pool size; neither is it known whether they will kill the eggs. Market preparations will kill the adults but not the eggs. The method in public aquariums is to remove the fishes, hand pick them, scrape the eggs off the glass and thoroughly scrub the tank.

Salt solution is of no avail. The parasites are not injured by transfer to extremely salt water which would kill the fishes.

1031. How can a garden pool be rid of anchor parasites (*Lernæa*)?

The method with *Lernæa* is the same as that with argulids, and here, also, prevention is far better than cure.

1032. How can tropicals be rid of the Itch in a garden pool?

They must be removed to aquaria and treated (see No. 984) and the pool left without fishes for 10 days.

1033. What is blister disease?

This disease appears when the blue-green alga is present in garden pools, and is so named by Niklitschek who says it kills Paradise and other fish in one or two days. Water conditions render the fish a prey to the blue-green alga, which coats the scales, closes the lateral line, clogs the gills and stops respiration. Blue-green algæ have been known to kill all the fishes (Perch) in a 500 gallon exhibition tank within a day after their peculiar color was observed.

" The remedy is to ~~hold~~ ^{fill} the pool of blue-green algæ and sterilize the fishes in a salt bath. Try to discover and remove the foul condition which caused the presence of the blue-green algæ. Run fresh water into the pool.

1034. Which fishes are best for garden pools?

In the east—Goldfishes, the small docile Sunfishes (Little, Diamond and Black-banded), Suckers, Black-banded Dace, Pearl and Common Roach, small Catfishes, Chubs, Red-bellied Dace, Silverfins, and Paradise Fish.

In the middle west—Goldfishes, Red-bellied Dace, Silver Dace and Black-nosed Dace, Minnows (except Mud Minnows), Pearl Roach and Darters, and the Orange-spotted Sunfish.

In the west—Goldfishes, western Dace and Minnows such as Blackfishes (*Orthodon microlepidotus*), the *traski* (*Hysterochampus traski*), Split-tail Hitch or Chigh (*Lavinia exilicauda*), which is widely distributed throughout California in rivers, and the Desert Minnow; the western Blob or Fresh-water Sculpin (*Cottus gulosus*), Paradise Fish, Rosy Barb, Common Roach, Mosquito Fish, Medaka, Japanese Bitterling, and many others.

Some European fishes may be used in garden pools, as the Tench and Ide. The latter is gluttonous and speedy and will rob other fishes of food thrown in. In public aquariums it is customary in such cases to toss food into two parts of the tank at once so that all the fishes may receive a share.

1035. Which are the best mosquito destroyers for the garden pool?

Among fishes native to or introduced into the northern states are Roaches, Sunfishes, Goldfishes, Fresh-water Killie and Southern Killie, Star-headed Minnow, Brook Silversides, Pirate Perch and Top Minnows, particularly *Gambusia* and *Heterandria*. (Bibliography No. 112.)

Among toy tropicals are the Mosquito Fish, the Mollies, Guppy, Swordtail Characin, Riddle's Tetra, Brackish Water Millions, Everglades Pigmy Sunfish, King Coscorob, *Tetragonopterus guppyi*, *Hemigrammus unilineatus*, *Rivulus harti* and Blue Acara. Most Florida Killies also are excellent for this purpose (see Nos. 429-433).

1036. Which fishes are the best mosquito destroyers for brackish water pools?

In the north—brackish water Killies, particularly the Sheepshead Minnow and Little Killie or Rainwater Fish, also the American Top

Minnow, which, though typically a fresh-water species, adapts itself in a state of nature to brackish and salt water.

In the south—the Mayfish (*Fundulus Amnis*) and other species of *Fundulus*, also the Little Killie, Brackish Water Millions, *Gambusia*, Mollies and Everglades Pigmy Sunfish,

In the west—*Gambusia* where they have been introduced, also the Small-fin Killifish (*Fundulus parvipinnis*).

1037. Should fishes kept in garden pools be taken indoors during the winter?

If the pools are shallow or the bottom foul, they should be removed indoors in states where freezing occurs. If the pools are deep, three feet or more, Goldfishes will winter though the water is freezing, and Paradise Fishes have wintered in water near the freezing point. Tropical fishes other than Paradise Fishes will not survive.

In experiments made by two young men who owned garden tubs, Goldfishes belonging to one froze in the ice and thawed out several weeks later; but those belonging to the other remained below as the surface froze, and suffocated when the oxygen was exhausted. Dr. Nicholas A. Borodin believes that the heart and tissues of the Goldfishes embedded in the ice did not freeze. His experiments in freezing fishes show that unless the heart is frozen, the fish will recover.

A common practise is to break the ice in shallow pools in order to admit oxygen, but although fishes which are warm and active are not often permanently injured by concussion (see No. 88), it is now believed that when chilled they may suffer severely from concussion due to having ice broken above them in shallow pools. There is no objection to this practise in large pools. The United States Bureau of Fisheries recommends covering the small, shallow pool entirely with netting upon which straw, leaves or other insulating material may be placed; or placing a bundle of straw in the pool so that when ice forms it will not completely seal the surface.

1038. When is a good time to take the fishes indoors for the winter?

About the middle of September, where the winters are cold. Always use the same water the fishes have been in, unless it is foul.

1039. Should the water be drained from the pool when the fishes are taken indoors for the winter?

Large pools need not be drained if it is possible to cover them

with boards and straw or leaves. If they cannot be covered, it is best to drain them.

Hardy water lilies will come through safely if the crown of the plants is not frozen, and so it is best to remove them to deeper water if they are to be left out for the winter. If the pool is drained, leave the drain open and fill the pool with old leaves.

1040. What is the cause of the high death rate among fishes transferred to indoor aquariums from outdoor pools?

In most cases this is due to overcrowding, a deficiency of oxygen, and too sudden changes in temperature and water.

1041. Do fishes left outdoors require feeding in winter?

Goldfishes, Tench and other pond fishes will winter unfed in larger pools if there are 15 or more inches of water beneath the ice. Fishes are inactive when the water falls below 50° and naturally hibernate, going without food during this period. However, where the temperature is above 50°, fishes require some food at least once a week.

1042. What natural enemies of fishes should be expected in the garden pool?

Water beetles leave the wild ponds during the night, returning to water in the morning. They prey on fishes and will make havoc if they get into your garden pool. Electric Light Bugs may be attracted by a light near the pool, drop in and make a midnight supper of your specimens. Water Boatmen and Back Swimmers eat small fishes and tadpoles. (See Enemies of Fishes, No. 176.)

Barn rats will enter the water to catch fishes, as will many wild animals, including mink and aquatic birds, also kingfishers, and the entire cat family has a tooth for fish equaled only by that of human beings.

A clever New Zealand aquarist arranged a seesaw at the point where a neighbor's cat entered her house pond to fish, so that when pussy stepped on the plank it tipped her into the water and she desisted from fishing in that pond rather than get her feet wet. We enjoy seeing a clever cat flip the Minnows out of a tide-pool into his mouth, or stand up on his hind legs to catch them in his mouth as they are tossed to him, and we cannot expect him to understand that our aquarium and garden pool specimens are more valuable.

1043. Will Goldfishes destroy mosquito wigglers and aphids in a garden pool?

Yes, the aphids must be washed from the lily pads into the pool with a hose.

THE GARDEN TUB

1044. What is the quickest and easiest way to make a small water garden?

Procure a second-hand bath tub or watering trough, half a head or any receptacle that will hold water, and sink it to four inches above the ground so that no water can drain in from the surrounding earth. Lay six or eight inches of soil on the bottom and plant with aquarium plants such as *Anacharis* and *Vallisneria*, and small water lilies, covering the soil with coarse sand to prevent the fishes from disturbing it.

Rocks may be placed around the tub in irregular fashion to suit one's fancy, and rock or border plants used around the edge.

1045. How many Goldfishes can be maintained in a garden tub?

A ratio of eight, not over five inches long, for every 50 gallons of water will be the correct number.

THE TERRARIUM

1046. What is a terrarium?

As aqua means water and terra means land, so the aquarium is for water animals and the terrarium for land animals or lung-breathing water animals that seek the air for considerable periods. "A vivarium for land animals," is the dictionary definition, and a terrarium when ready for its occupants has been more intimately described as a receptacle containing "stones, moss and a tiny pond of water."

Terrarium animals are amphibians or reptiles, the former being frogs, toads and salamanders, the latter lizards, turtles, tortoises, snakes and young alligators.

Some of the most beautiful of modern gardens in glass are planted in immense bottles (pale green or colorless) with small mouths. These, like bowls containing checker-berries and mosses, and rectangular glass receptacles containing a variety of plants, with covers to conserve moisture, cannot properly be called terrariums. Similarly, glass receptacles containing only aquatic plants are under-water gardens and not aquariums.

1047. How can one construct a terrarium?

Terrariums are purchasable, some having a lower level for the water, which may be drained off. An aquarium may be transformed into a terrarium by covering the bottom with sand, laying rich earth over this and planting with mosses, wood ferns, checker-berries and other moisture-loving plants. Many an old aquarium has been converted in this manner into a thing of beauty. Such a terrarium is suitable for land turtles and other terrestrial animals of small size which will drink from a small dish of water sunk to the level of the earth.

For lung-breathing water animals the terrarium must be provided with a small pool. This type of terrarium may be constructed by using an aquarium and enclosing the planted section firmly within plate glass or cemented stones, so that the animals can enter and leave the water at will. (The same care in curing the cement must be taken as described in its use for garden pools. See No. 995.) If the



Courtesy Nature Magazine

The terrarium is for amphibians and reptiles, such as frogs and toads, lizards and salamanders, turtles, tortoises, snakes and baby alligators. The frogs are enjoying a warm shower from the garden watering pet.

water is provided in a shallow dish sunk to the level of the surrounding ground, this can be removed for cleaning. For this type of terrarium young water turtles, salamanders and small frogs are suitable, also very young alligators.

A new type of "aqua-terrarium" is so arranged that the pool (five or six inches deep) occupies the entire front half of the tank and is stocked only with toy fishes, the rear half being built up to the level of the water and devoted to terrestrial plants. Like some terraria, this receptacle is fitted with a glass cover raised slightly to admit air.

1048. How is the terrarium kept clean?

In the case of animals which spend considerable time in the water (frogs, salamanders, turtles and alligators) the terrarium will require cleaning three times a week. In the case of land animals such as small tortoises, snakes and lizards, once a month is sufficient. If water is not provided in a removable dish or a terrarium having an outlet, it can be siphoned off or sopped out with a sponge.

TADPOLES, FROGS AND TOADS**1049. Of what use are tadpoles?**

The frog tadpole, like the American Catfishes, has passed largely out of favor though still a desirable adjunct to the Goldfish tank because it is omnivorous, always hungry, and consumes not only the algæ forming on plants and glass, but seldom misses the scraps of food overlooked by the fishes. One tadpole is sufficient for Goldfish and native fish aquaria of from three to 15 gallons' capacity.

Only the smallest specimens should be introduced in the fall or winter, for by spring most tadpoles have developed their legs, changed their method of feeding, and should be liberated in a pond or lake where they can catch the live food now required—flies, worms, aquatic insects and the like, or maintained in a terrarium. Tadpoles, like fishes, are fatally sensitive to sudden and drastic changes in the quality and temperature of the water.

1050. How can one keep a frog or toad in captivity?

Frogs and toads (including tree toads) must be provided with terraria so arranged that they can have both land and water, and should be fed earthworms, mealworms, flies, beetles, moths, bugs, caterpillars, or any other available worms or insects. Sometimes they will take scraps of raw meat pressed around a string and dangled before them to appear alive.

Frogs spend more time in the water than toads, preying on little fishes, tadpoles and other small creatures; but toads seek the water to imbibe it through their skins (their way of drinking), or to breed. They soon die if deprived of moisture.

Tree frogs thrive in terraria, singing in the late afternoon.

1051. What is the difference between frogs' eggs and toads' eggs?

Frogs' eggs are laid in jellylike masses at the bottom of the pond. Toads' eggs are laid in long strips of jelly in shallower water. The

eggs of the tree toad, however, are laid singly in a jellylike substance and attached to a submerged plant or rock.

The common bullfrog breeds from May to July, the leopard green and pickerel frogs throughout the month of April. Tree frogs' eggs are laid in April. Toads breed in May and June.

1052. When do frogs' and toads' eggs hatch and how long do the tadpoles remain in the water?

They hatch according to species, in from one to two weeks, though the common toad tadpole is out of the egg in four or five days.

Green frogs and bullfrogs generally remain in the tadpole stage for two years, though many others metamorphose in one year. Toad tadpoles change in two or three months, and when just about large enough to sit upon one's little finger nail may be seen emerging from the water in great numbers while the weather is balmy and insects are plentiful.

1053. What is a spring peeper?

A tree toad, called also Pickering's *Hyla* in the east and *Hyla* in the west.

SALAMANDERS AND TURTLES

1054. Should salamanders and turtles be kept with fishes?

Salamanders and turtles nibble at the fins of fishes, and a salamander was observed to eat 40 little fishes in one hour; but more often it is a question of whether the salamander will attack the fish or the fish will succeed first in chewing off the salamander's toes. Salamanders are afraid of fishes larger than themselves. Turtles also prey on salamanders.

Turtles and salamanders are air breathers, being provided with lungs and not gills (though salamanders pass through a tadpole stage similar to that of frogs) and these two animals require facilities for crawling out on land. A terrarium, therefore, is best for them, though "floating islands" made of cork have been used successfully in aquariums for their escape from the water. In the pond, logs and water lily leaves serve this purpose.

1055. Is "lizard" another name for salamander?

No, salamanders are not related in any way to lizards, and it is an error to call the water-loving salamander a lizard. Salamanders,

like frogs and toads, are amphibians, i. e., animals which in general are hatched in the water as tadpoles, and many undergo a metamorphosis during which lungs or legs or both are developed. There are some exceptions to this rule, however, as the Red-backed Salamander (*Plethodon cinereus*) which passes its entire life on land. Lizards are scaly reptiles related to snakes and tortoises, born on dry land, almost never living in the water and undergoing no metamorphosis. Some have claws. The salamanders are without scales and claws. The common chameleon, for example, is a lizard; the common newt is a salamander. This newt (*Triturus viridescens*) in the young stage spends two or three years on land, is then a bright orange red with a row of scarlet spots on the side, and is called the Red Eft, or Land Newt. On returning to the water it turns green, retaining its scarlet spots. The Pacific newt (*T. torosus*) has similar habits and colors.

1056. Can salamanders be bred in captivity, and what food do they require?

They will breed under conditions simulating their natural habitat in the wild ponds. The eggs of most species are laid in a gelatinous mass, attached to plants, are firmer than frogs' eggs and slightly larger. They hatch in from two weeks to two months according to species. The larvæ have external gills like tadpoles and some species lose their gills in less than two months, others not for several years. Their development can be retarded indefinitely in cold flowing water if one wishes to keep them in the tadpole stage.

The newt breeds in April and May and in this species the adhesive eggs are laid one at a time. The young remain in the water until fall, when they enter upon the land stage. Most other salamanders also breed in spring, but the Marbled Salamander (*Ambystoma opacum*) lays its eggs in autumn. In this species and in the Dusky Salamander (*Desmognathus fuscus*) the mother guards the eggs by coiling her body about them.

The natural food of most salamanders consists principally of worms and insects, snails, tadpoles, fish fry, and other salamanders. In captivity they take chopped clams and other shellfish, also meal-worms and small earthworms, ground beef heart, and fish.

In a state of nature the common newt in the land form eats insects and caterpillars, being especially fond of aphids. In the later, aquatic stage, it is said to prey on *Hydra*, sow-bugs and fresh-water sponges.

1057. Can the sexes of salamanders be distinguished?

Most males are swollen about the cloaca, and in some species, as in the common newt, the rear legs of the male are larger than those of the female.

1058. If salamanders become injured and develop fungus, what can be done for them?

Soak the injured parts in kerosene for a few minutes, rinse in clear water and transfer to a tank with loose mud on the bottom. They will come forth whole after the necessary period of rest and mud bathing, which differs according to the extent of the injury.

1059. What food do turtles take?

Water turtles eat meat, fish and snails, and some like floating plants such as *Salvinia*, *Lemna* and *Azolla*. They swallow their food under water.

Land turtles, such as common Box tortoises, like berries, bananas, mushrooms, earthworms, insects, meat, fish, apples, celery, tomatoes, bread and crickets. They will eat lettuce and other tender vegetables.

1060. Is it necessary for turtles to hibernate?

It is their nature to do so, water turtles burying in the mud at the bottom of the lakes and ponds, and land turtles (called tortoises) burrowing in earth below the frost line. While they have been kept for years without hibernating (as in public aquarium pools and in refrigeriums), animals are happier and healthier if permitted to follow their natural bent.

1061. What causes sore eyes in turtles kept indoors?

Lack of sunshine and foul water will cause eye disease.

The remedy is sunshine, a chance to bury in mud, and boric acid solution, collyrium or other eye wash dropped gently on the eyes.

1062. Why do turtles' shells become soft?

Because of lack of sunshine, mud, and lime foods for shell building.

This is a serious condition, but they are worth trying to save. Feed with pond snails or fish with the bone ground in, and provide direct sunshine for them to bask in. They should be allowed to

hibernate in mud in a cool but not freezing place in winter, but they should go into hibernation healthy and fat in order to come out well in the spring.

1063. What is the difference between a turtle, a tortoise and a terrapin?

Zoological classification recognizes only turtles and tortoises. Most fresh-water species and all marine species are called turtles, and most terrestrial species are called tortoises. The commercial word, terrapin, is applied to salt-marsh species such as the Diamond-back (*Malaclemys palustris*); and the Red-bellied Slider or Cooter (*Pseudemys rubriventris*) is marketed as a substitute for the Diamond-back and called a terrapin. The Yellow-bellied turtle (*Chrysemys scabra*) also is commonly called a terrapin.

1064. What are the names of little turtles commonly sold in pet shops in the eastern states?

Those with bright green shells and a wide red stripe from the eye backward along the neck, are Cumberland turtles. The lower shell is marked with numerous irregular double green rings having yellow centers.

The small black turtles with a thin yellow stripe down the back are common Pond or Painted turtles. They lose this stripe later and the border of the shell becomes mottled with red.

The turtles with "water-marked" grayish brown upper shell (carapace) and yellow lower shell (plastron) are Geographic turtles. A deep yellow line runs backward from the snout, with similar circular lines around the eyes. There is a distinct black dorsal ridge like a little chain of mountains, and the plastron is finely marbled in regular patterns.

The turtles with dark green carapace and a yellow plastron marked with irregular black splotches are Yellow-bellied terrapin. The shell is slightly arched at the center of the back.

All the foregoing are native to the southern and middle western states except the Painted turtle, which is common in the New England and middle Atlantic region.

1065. Which turtles can one collect from the ponds?

In the south, those named in the preceding answer except for the Painted turtle.

Other southern turtles are the Spiny, Southern, and other species of *Trionyx* or Soft-shelled turtles, with pointed snouts, leathery,

- spotted backs and white plastrons. Although fierce fighters they are delicate species in captivity, requiring sand or mud in which to bury and soft foundations which will not bruise them.

The Diamond-back terrapin is another southerly species of the salt marshes which formerly ranged north but has grown scarce from over-fishing.

In the middle west, the Western Painted turtle is fairly common.

Other common northern species are the dull black Mud and Musk turtles, looking somewhat alike, with broad heads and pointed snouts, and distinguished by the wide under shell of the Mud Turtle. They are biters and fond of muddy waters. There are several western species of Mud turtle, including the Pacific and Sonoran.

The Spotted turtle has a black shell with numerous round yellow spots, is shiny like the Painted turtle, and a handsome species.

The Snapping turtle's pointed head, dull black shell and much abbreviated plastron easily identify it. It is safe only when very young, the power of the jaws being great in the older stages. If you wish to protect a Snapper which has wandered upon the roadway, pick it up by the tail and carry it to a point of safety; or place a stout stick close to the jaws. It will lay hold of the stick and can be conveyed thus.

1065. Which are the common land tortoises?

In the woods of the northeastern states one will find the Wood tortoise with dark brown upper plated shell lined with many concentric ridges and in which all fleshy parts except the top of the head are brick red.

The common Box tortoise easily is identified by its hinged shell into which it can withdraw. The back is dome-shaped, the color usually is brown marked with yellow.

These two make most pleasing pets, learning to come when called and to eat from the fingers. Box tortoises, when allowed to bury for the winter, have survived for more than 50 years in captivity. They dig down below the general frost line, from 14 to 18 inches, and come out in the spring very hungry. In some states it is against the law to possess either Wood or Box tortoises.

In the south is the Gopher tortoise, which burrows in dry, sandy places and requires warm, dry quarters. It has a celebrated appetite for sweet potatoes and eats also grass, lettuce, berries and bananas. One kept in the laboratory of the New York Aquarium learned to know when lunch hour had arrived and would go to its keeper seated at his desk with a ham sandwich and pull at his trousers until it received a bit of the bread and meat.

The Desert tortoise of California (*Gopherus agassizii*), with high domed body, feeds largely on the blossoms and leaves of desert plants, also on insects, and does well in captivity.

These and other tortoises make delightful pets and live for many years when properly cared for.

1057. Can young sea turtles be kept in captivity?

People who live in the tropics may have the joy of keeping young sea turtles in shallow salt-water tanks. All are charming, and he is indeed a favored mortal who is privileged to give their breakfast to half a dozen baby Loggerheads or Hawksbills, paddling toward him with long, winglike flippers, every little beak open like those of fledglings in the nest when father brings a worm.

Sometimes these infant turtles have been successfully shipped north, and will grow and thrive with proper care.

Sea turtles like to bask in warm sand.

ALLIGATORS

1068. What can one do with a baby alligator which refuses to eat?

Warm it up—not on a hot radiator where it may roast to death, but in warm water. Alligators become torpid in winter even in California and Florida, the young require extra warmth for some months after hatching, and adults kept in northern states should be maintained in a conservatory or in heated pools.

Baby alligators require meat and fish, and they are fond of mice and young rats.

1069. If an alligator's snout becomes bruised and fungused, what can be done for it?

Dip a rag in kerosene and swab the bruised snout with it. Kerosene is a magic remedy for many water animals.

LIZARDS AND SNAKES

1070. What care do tree lizards require?

They require a terrarium of the kind described for land animals, with branches to climb among. Lizards like sunshine and warmth. The "American Chameleon" (*Anolis carolinensis*) generally takes mealworms, wax-worms, roaches, flies and other live insects.

• A little girl once succeeded with a "chameleon" by feeding it with condensed milk diluted with water. It is customary to feed with sweetened water, not given in a dish but sprinkled on plants and about their quarters daily. They will go for weeks without food, especially if not kept warm. Some lizards absorb drops of water sprinkled on their backs, others learn to take water or milk from a medicine dropper.

True chameleons are found only in Europe, Asia, Madagascar and Africa, and are noted for their ability to change color. These color changes are effected by contractile pigment cells which can be pressed toward the surface of the skin.

1071. What care do desert lizards such as the Gila Monster (*Heloderma*) and Horned Toad (*Phrynosoma*) require?

The Gila Monster, a native of the arid regions of Arizona and New Mexico, is hardy in captivity, having been kept successfully for eight years in a terrarium 24 inches long, 18 inches high and 20 inches wide. The bottom should be covered with three inches of white beach sand and a temperature of 78° maintained.* This is easily accomplished with a 40 watt incandescent lamp, suspended near the top of the receptacle. The foods most liked are chopped beef and raw eggs beaten, one or the other of which should be fed twice a week during the winter and three times a week in summer. The Gila Monster is one of only three lizards known to be poisonous, but it becomes so sluggish in captivity as to appear quite inoffensive.

Horned toads, indigenous to our western and southern states and northern Mexico, also other desert lizards, may be provided with similar quarters, but the foods preferred are insects and insect larvæ, ants, moths, flies and worms.

Horned toads are the most captivating of all lizards and entirely harmless. They require sunshine to bask in by day and sand to burrow in by night, and, like chameleons, take their water in drops. They have a singular habit, when frightened or disturbed, of squirting blood from the eye. In a natural state, the Horned Toad brings forth as many as 24 living young at one birth, but animals like these seldom breed in captivity.

There are many American species of lizards, which include the Geckos with circular pads on their toes, fence lizards, tree lizards, rock lizards, mountain lizards, horned toads, swifts and skinks. Twenty-eight species are found in southern California. (Bibliography No. 56.)

* All temperatures are Fahrenheit.

1072. What kind of terrarium is best for snakes?

With the exception of garter snakes, which like a moist environment, they require dry quarters, and an old aquarium fitted with a wire cover makes a good home for them. They like branches to coil on. Select smooth pebbles or plain sand or both, for the bottom. Snakes require water to drink like all other reptiles, and sun to bask in.

1073. Which small species of snakes are most desirable for the terrarium?

The Garter snake is most familiar, harmless, and soon tamed. It is largely distributed over the United States in various allied forms. Its natural food consists of fishes, frogs, and toads; and in captivity it will take earthworms.

The Green snake, also widely distributed, is of good disposition and lives on insects and bugs, with a preference for caterpillars, spiders and roaches.

Only young specimens of the Milk snake, Gopher and King snakes are suitable for the terrarium, but may be liberated when grown too large for their quarters. Dr. Raymond L. Ditmars has found the Gopher snake not only beautiful but affectionate. King snakes are friendly to people but will attack other species of snakes. The Green snake, Dr. Ditmars says, cannot be induced to bite. (Bibliography No. 39.)

More than 25 species of harmless snakes are found in California, including the Garter, Gopher, and King snakes, Worm snakes, Racers, and Ground snakes.

1074. What food is best for small snakes?

Like lizards, the majority refuse anything but living, moving animals. Their natural food consists of rodents (rats, mice, rabbits), toads, frogs, birds—and other snakes. Mealworms, wax-worms, earthworms and small mice are suitable for most young snakes except the Green snakes. (See No. 1073.) King snakes will accept raw meat. Like lizards, snakes will go without food for weeks in winter, especially if not kept warm enough.

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